SITE: Woolfolk
BREAK: 4.9
OTHER:

RESPONSE ACTION CONTRACT
FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND NON-TIME
CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR
THREATENED RELEASE OF HAZARDOUS SUBSTANCES IN REGION VIII

Prepared for:
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4

FINAL
FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 4 WOOLFOLK CHEMICAL WORKS SUPERFUND SITE FORT VALLEY, GEORGIA

OCTOBER 18, 2002

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Acronyms and Abbreviations

AOC	Administrative Order of Consent
ARAR	applicable or relevant and appropriate requirement
BAP	benzo(a)pyrene
BRA	baseline risk assessment
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
CGC	Canadyne-Georgia Corporation
COC	contaminant of concern
COPC	contaminant of potential concern
CPAH	carcinogenic polycyclic aromatic hydrocarbon
cy	cubic yard
DMA	2,4-dimethylamine
EPA	U.S. Environmental Protection Agency
F	Fahrenheit
FS	feasibility study
GRA	general response action
HEPA	high-efficiency particulate air
HI	hazard index
HQ	hazard quotient
ILCR	incremental lifetime cancer risk
K_{oc}	organic carbon/water partition coefficient
K_d	soil/water partition coefficient
K_{ow}	octanol-water partition coefficient
mg/kg	milligrams per kilogram
MLK Jr. Drive	Martin Luther King, Jr. Drive
MMA	methylamine
M/T/V	mobility/toxicity/volume
NCP	National Contingency Plan
ng/kg	nanograms per kilogram
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OCGA	Official Code of Georgia
O&M	operation and maintenance

OU	operable unit
PCB	polychlorinated biphenyl
PCPI	Peach County Properties, Inc.
PRG	preliminary remediation goal
PRP	potentially responsible party
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RG	remediation goal
RGO	remedial goal option
RI	remedial investigation
ROD	Record of Decision
SERA	screening-level ecological risk assessment
SVOC	semivolatile organic compound
TEQ	toxicity equivalent quotient
USACE	U.S. Army Corps of Engineers
USC	United States Code
USGS	U.S. Geological Survey
VOC	volatile organic compound
WCW	Woolfolk Chemical Works

Executive Summary

The former Woolfolk Chemical Works (WCW) includes an abandoned insecticide, pesticide, and herbicide production and packaging facility that encompasses an 18 acre area within the central business district of Fort Valley, Georgia. From 1926 to 1998, the site was used for the production and packaging of organic and inorganic insecticides (including arsenic and lead-based products), pesticides, and herbicides.

In 1986, the U.S. Environmental Protection Agency (EPA) began investigations of the release or potential release of hazardous substances at the facility and requested all analytical data pertaining to the facility. This investigation led to the proposal to add the Site to the National Priorities List (NPL) in June 1988. In August 1990, the WCW facility was placed on the NPL.

In 1993, the site was divided into two operable units (OUs): OU-1 for groundwater, and OU-2 for the remaining contaminated areas. A Record of Decision (ROD) for OU-1 was issued on March 25, 1994. In April 1995, EPA further divided the site into OU-2 for properties of a proposed redevelopment project, and OU-3 for remaining portions of the site. EPA issued a ROD for OU-2 on September 30, 1995, and the ROD for OU-3 was issued on August 6, 1998. An additional operable unit, OU-4, was created in October 1995 to address remaining off-site contamination. OU-4 consists of off-site soil on residential and commercial properties, contamination of the drainage pathway from the former facility to Big Indian Creek, and dust in the attics of surrounding homes.

In October 1999, EPA contracted with CDM Federal Programs Corporation (CDM) to complete a Remedial Investigation/Feasibility Study (RI/FS) of OU-4. The primary objectives of this FS are to: identify remediation goals for contaminated media; determine the extent of contamination above remediation goals; present remedial action objectives (RAOs) for contamination; develop general response actions (GRAs); identify, screen, and select remedial technologies and process options applicable to the contamination associated with the site; and develop and analyze remedial action alternatives. The FS report will be used to support subsequent decision documents, and the design and implementation of remedial actions for site-related WCW OU-4 contamination.

Following determination of contaminated media, GRAs were identified. The most appropriate technologies applicable to the contamination at the site were chosen for each of the GRAs. Specific process options were then selected to represent those technologies. Remedial action alternatives were used to develop a range of appropriate technologies for consideration. Remedial action alternatives were formulated considering the extent of contamination, contaminant type, contaminant concentrations, and applicable technologies. Four soil alternatives underwent a detailed evaluation on the basis of overall protection of human health and the environment; long-term effectiveness; compliance with applicable or relevant and appropriate requirements (ARARs); reduction of mobility, toxicity, and volume through treatment; short-term effectiveness; and cost. The final component of the FS was a comparative analysis of the alternatives based on the threshold and balancing criteria. The objective of this section is to compare and contrast the alternatives so that decision makers may select a preferred alternative for presentation in the ROD.

Table ES-1 presents a summary of each remedial alternative along with ranking scores for each evaluation criterion. Remedial alternatives for OU-4 surface soils include (1) no action; (2) excavation and treatment of soil at OU-3 via solidification/stabilization (S/S) and disposal of treated soil at OU-3; (3) excavation and treatment via S/S followed by off-site disposal in a Subtitle D landfill; and (4) excavation followed by off-site disposal in a Subtitle C or D landfill depending on soil characteristics, or use as an OU-3 backfill. Except for the no action alternative, each of the alternatives also includes an attic dust decontamination component. Each alternative's performance against the criteria (except for present worth) was ranked on a scale of 0 to 5, with 0 indicating that none of the criterion's requirements were met and 5 indicating all of the requirements were met. The ranking scores are not intended to be quantitative or additive, but rather are summary indicators of each alternative's performance against the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) evaluation criteria. The ranking scores combined with the present worth costs provide the basis for comparison among alternatives.

Table ES-1
Comparative Analysis of Remedial Alternatives
Woolfolk Chemical Works Site, OU-4, Fort Valley, Georgia

Remedial Alternative	Criteria Rating						Approximate Present Worth ($)
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability	
1 — No Action	0	0	0	0	5	5	$243,000
2 — Excavation, On-Site (OU-3) Treatment with Solidification/ Stabilization (S/S) and On-Site (OU-3) Disposal; Attic Dust Decontamination	5	5	5	4	4	4	$9.4 million
3 — Excavation, Treatment with S/S and Off-Site Disposal; Attic Dust Decontamination	5	5	5	4	3	3	$18 million
4 — Excavation, Off-Site Transportation with Disposal in Subtitle C or D Landfill, or use as OU3 Backfill; Attic Dust Decontamination	5	5	5	4	4	4	Subtitle C–$31.3 million Subtitle D–$15 million Use as OU-3 backfill–$5.3 million

A ranking of "0" indicates noncompliance, while a ranking of "5" indicates complete compliance.

Section 1
Introduction

The former Woolfolk Chemical Works (WCW) includes an abandoned insecticide, pesticide, and herbicide production and packaging facility that encompasses an 18 acre area within the central business district of Fort Valley, Georgia. From 1926 to 1998, the site was used for the production and packaging of organic and inorganic insecticides (including arsenic and lead-based products), pesticides, and herbicides. During World War II, an inorganic intermediate (arsenic trichloride) was reportedly produced at the facility for the War Production Board. Production was expanded during the 1950s to include the formulation of various organic pesticides, including DDT, lindane, toxaphene, and other chlorinated pesticides. These organic pesticides and other insecticides and herbicides were formulated, packaged, or warehoused at the facility.

In September 1986, Canadyne-Georgia Corporation (CGC) completed an interim, voluntary soil remediation at the WCW facility. That same year, the U.S. Environmental Protection Agency (EPA) began investigations of the release or potential release of hazardous substances at the facility and requested all analytical data pertaining to the facility. This investigation led to the proposal to add the Site to the National Priorities List (NPL) in June 1988. In April 1989, EPA notified potentially responsible parties (PRPs), including CGC, Sureco Inc., Peach County Properties, Inc. (PCPI), Marion Allen Corporation, and Boots Hercules/Nor-Am Corporation of their potential liability under the Comprehensive, Environmental Response, Compensation and Liability Act (CERCLA) for response costs incurred at the site. In April 1990, EPA and CGC completed negotiations on an Administrative Order on Consent (AOC) for Remedial Investigation/Feasibility Study (RI/FS). The AOC was signed on April 24, 1990. In August 1990, the WCW facility was placed on the NPL.

In 1993, the site was divided into two operable units (OUs): OU-1 for groundwater and OU-2 for the remaining contaminated areas. A Record of Decision (ROD) for OU-1 was issued on March 25, 1994. In April 1995, EPA further divided the site into OU-2 for properties of a proposed redevelopment project, and OU-3 for remaining portions of the site. EPA issued a ROD for OU-2 on September 30, 1995 and the ROD for OU-3 was issued on August 6, 1998. An additional operable unit, OU-4, was created in October 1995 to address remaining off-site contamination. OU-4 consists of off-site soil on residential and commercial properties, contamination of the drainage pathway from the former facility to Big Indian Creek, and dust in the attics of surrounding homes.

In October 1999, EPA contracted with CDM Federal Programs Corporation (CDM) to complete an RI/FS of OU-4. The objective of the RI was to define the nature and extent of the contamination in the off-site residential and non-residential soils, the attic dust in commercial and residential properties, and the sediment in the drainage pathway to Big Indian Creek.

The primary objectives of the FS are to: identify remediation goals for contaminated media; determine the extent of contamination above remediation goals; present remedial action objectives (RAOs) for contamination; develop general response actions (GRAs); identify, screen, and select remedial technologies and process options applicable to the contamination associated with the site; and develop and analyze remedial action alternatives. The FS will be used to support subsequent decision documents, and the design and implementation of remedial actions for site-related WCW OU-4 contamination. In order to maximize efficiency of the cleanup process and minimize impact to the community, remedial alternatives developed and considered for OU-4 were developed with the objective of being compatible with the alternatives developed and considered for OU-3.

The FS focused on development of alternatives to address contamination in off-site residential and nonresidential soils, attic dust and in sediments in uncovered portions of the drainage pathway stretching from the facility, southward along Preston Street, to Spillers Street. The extended time associated with completing the ecological risk assessment process on the remaining portion of the drainage ditch (Spillers Street southward to Big Indian Creek) makes it necessary to breakout that portion of drainage ditch from the rest of OU-4 by identifying it as a separate operable unit (OU-5).

This FS report has been prepared in accordance with EPA's document entitled, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final* (EPA 1988). This report thus provides the basis for remedy selection by EPA and the State of Georgia for the WCW OU-4 site, as well as the design and implementation of remedial actions at the site. This FS report consists of six main sections. Brief summaries of the remaining sections are presented below:

- Section 2 discusses applicable or relevant and appropriate requirements (ARARs) and the objectives of remedial action at the site. The objectives are developed to address the risks posed to human health and the environment by the contamination found at the site. This section also discusses the remediation goals for the media of concern, as well as the extent of contamination exceeding those goals.

- Section 3 identifies GRAs that will satisfy the cleanup objectives for the WCW OU-4 site. A wide range of technologies and process options that are applicable to the response actions and site characteristics are then identified and screened before assembly of remedial action alternatives. The screening process focuses on eliminating those technologies and process options that have severe limitations for a given set of waste- and site-specific conditions, as well as inherent technology limitations.

- Section 4 discusses the formulation of remedial action alternatives which is the combination of GRAs and process options chosen to represent the various technology types for each medium of concern. A range of alternatives was assembled that result in differing levels of site cleanup. These alternatives were developed and described in detail to facilitate subsequent screening. The alternatives were then evaluated to determine their overall effectiveness, implementability, and cost. Alternatives with the most favorable overall evaluations were retained to undergo detailed analysis. As stated previously, alternatives also were considered with the objective of being compatible with the alternatives developed for OU-3.

- Section 5 presents a detailed analysis of the remedial action alternatives that passed the screening process in Section 4. This analysis was performed to provide the necessary information for EPA and the State of Georgia to select a remedial action for implementation. The evaluation was based on a group of technical, environmental, human health, and institutional criteria. Cost estimates also were developed for each alternative.

- Section 6 compares and summarizes the effectiveness of each remedial action alternative analyzed.

- Section 7 provides references.

Section 2
Site Characterization

2.1 Site Description

The following information is taken from the Data Evaluation Report prepared for the WCW OU-4 Site (CDM 2001a).

2.1.1 Site Location

The former WCW Facility is located in Fort Valley, Peach County, Georgia, and includes 18 acres located within the central business district of Fort Valley, Georgia (Figure 2-l). The facility is bounded by Railroad Street to the northwest, Martin Luther King Jr. (MLK Jr.) Drive to the northeast, residential and commercial properties to the southeast, and Preston and Pine Streets to the southwest. OU-4 includes off-site surface soil, dust in commercial and residential properties, and the sediment in the drainage pathway that leads from the facility to Big Indian Creek.

2.1.2 Site History

The former WCW facility was used for the production and packaging of organic and inorganic insecticides (including arsenic and lead-based products), pesticides, and herbicides.

The J. W. Woolfolk Company owned and operated the facility from 1926 until 1941, when it dissolved and conveyed its assets to Woolfolk Chemical Works, Ltd. Woolfolk Chemical Works, Ltd., reorganized into the corporation Woolfolk Chemical Works, Inc., in 1972. In 1977, Reichold Limited acquired all of the stock of Woolfolk Chemical Works, Inc., pursuant to a stock purchase agreement. The stock purchase agreement was assigned to Canadyne Corporation a wholly-owned subsidiary of Reichold Limited. In 1984, Woolfolk Chemical Works, Inc., changed its name to Canadyne-Georgia Corporation (CGC). Also in 1984, the facility was sold to Peach County Properties, Inc. (PCPI). PCPI is the current owner of most of the former Woolfolk property, and has leased most of the property to its affiliate, SurePack. Inc., which has formulated and packaged pesticides at the facility since 1984. Another portion of the property is leased to Georgia Ag. Chemicals, which operates a warehouse and distribution facility. CGC currently retains the title to a one-acre parcel of the facility used as a landfill. Marion Allen Insurance and Realty Company also owns one parcel located northeast of the facility.

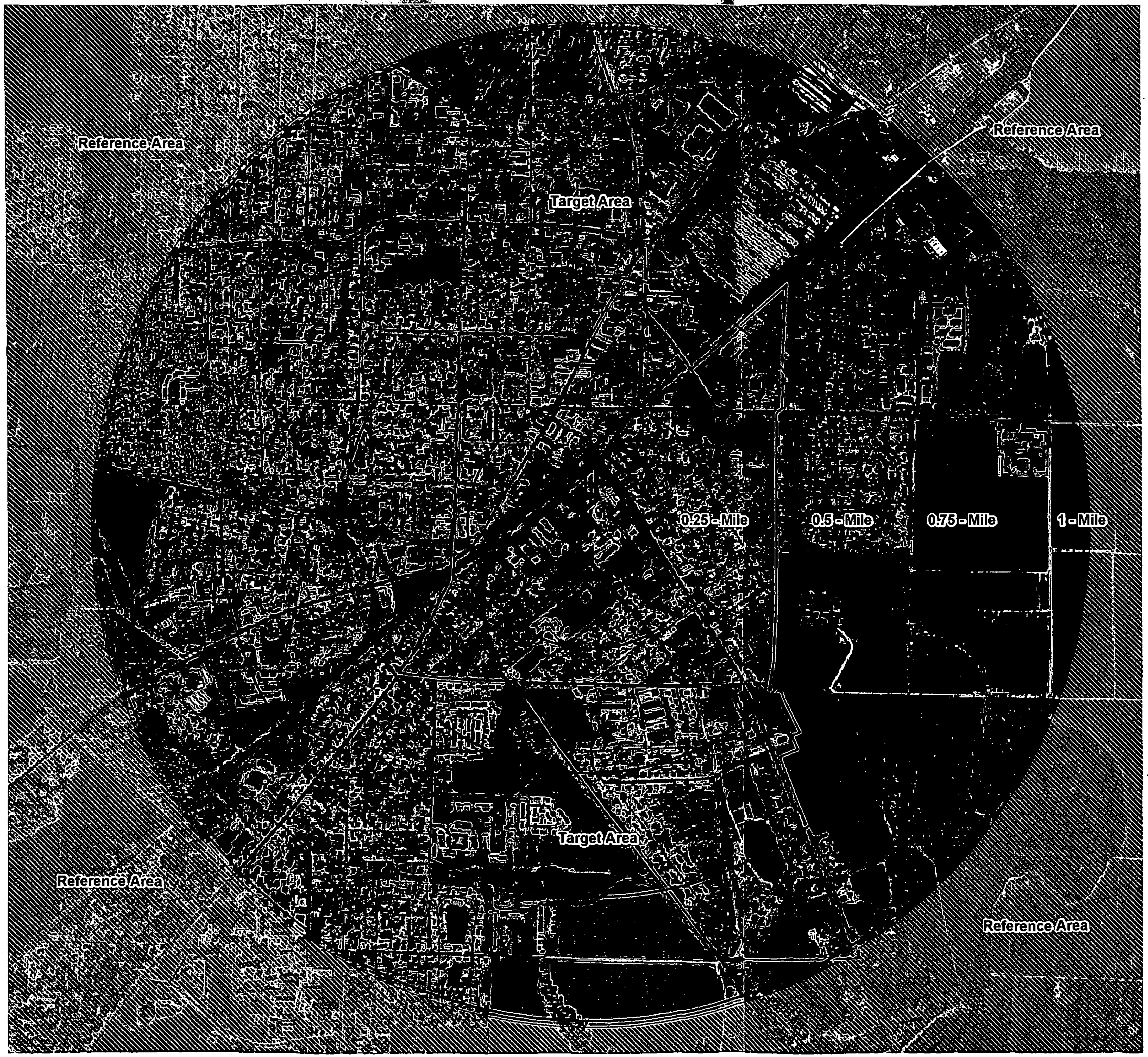

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Figure 2-1
Site Layout
Woolfolk Chemical Works Site OU4 RI/FS
Fort Valley, Georgia

Legend

Reference Area
Operable Unit 2 Boundary
Operable Unit 3 Boundary
Operable Unit 4 Boundary

CDM

2.1.3 Site and Regional Setting

2.1.3.1 Site and Local Surface Water Pathways

The information presented in this section is based on the *Final Remedial Investigation Report, Woolfolk Chemical Works Site, Fort Valley, Georgia* (CH2M HILL November 1992), review of United States Geological Survey (USGS) topographic maps (USGS 1972a, 1972b, 1973, and 1974), and observations made by CDM during a site visit on December 2, 1999.

The former WCW facility lies within Fort Valley Plateau District of the Coastal Plain Physiographic Province. The Fort Valley Plateau District is characterized by broad, flat topography, with few streams and low local relief. The Fort Valley Plateau is a gently rolling area that slopes to the southeast. South of Fort Valley, streams are somewhat more incised into the plateau, and relief in the streams ranges up to 100 feet in some areas along Big Indian Creek.

The former WCW facility is generally flat to gently sloping, with a slope of about 1 percent toward the south. No surface water bodies or rivers exist at the former facility. The surface water runoff drainage system from the site, including some portion of Big Indian Creek, are included in OU-4.

Surface water runoff from the facility collects in a series of open ditches along Preston Street. The runoff flows through a series of ditches, crossing Spruce Street, and then Lavender Street until discharging from a culvert into the Falls Branch tributary to Big Indian Creek at the south end of Spillers Street. A portion of the sediments in the ditch from the site to Lavender Street have been remediated. The remaining areas of the ditch will be excavated during the OU-3 remediation. In the past, water was reported to have backed up in a tributary ditch north of Lavender Street.

At the discharge point (at the end of Spillers Street) the channel of the Falls Branch tributary is relatively narrow (4 to 5 feet wide) and has very narrow recent terraces (0 to 0.5 feet wide). An older, wider (30 to 40 feet wide) terrace is present along the upper part of the tributary. The sediments within the channel are sandy, and the stream itself can be seen to flow on a kaolinite layer. Farther south, but still north of the railroad tracks, the upper terrace is less well defined or absent. Approximately 1/4 mile south of the railroad tracks, the channel broadens and, at the time of the site visit, was dry. The tributary narrows again as it flows southward toward University Boulevard. As the tributary emerges from the wood line along University Boulevard, it is very shallow and narrow. The stream turns west, running along the wood line, then turns south and goes beneath University Boulevard via a large concrete culvert.

South of University Boulevard, the stream appears to receive additional water from runoff from the east end of the street. A very silty drainage ditch running along the south side of University Boulevard was observed running toward the tributary, although no water was flowing in either drainage path during the December 2, 1999, site visit. As Falls Branch re-enters the woods south of the road, the material in the stream bed is considerably siltier than was observed between Spillers Street and University Boulevard.

About 4,000 feet south of University Boulevard, the stream broadens into a swampy area, with no distinct channel. During the December 1999 site visit, water was present throughout this area. Water marks on trees were approximately 1.5 to 2 feet above the water surface at the time of the site visit, providing evidence that the water at that time was relatively low. The tributary remains a broad swamp for at least another 4,000 feet before returning to a more distinct channel by the time it reaches Carver Road. Approximately 2,000 feet south of Carver Road, Falls Branch discharges into Big Indian Creek.

2.1.3.2 Site Physiography and Climate

The climatological data presented here is taken from the Southeast Regional Climate Center data for the Macon Airport, Georgia Station, collected from 1961 to 1990. The average annual precipitation at that location is 44.65 inches, with the highest monthly precipitation occurring in March (4.79 inches) and February (4.74 inches). The lowest average precipitation occurs in October (2.18 inches). The area receives an average of 1.4 inches of snow annually. Average temperatures range from 45.5° Fahrenheit (F) in January to 81.5°F in July.

2.1.3.3 Site Geology

The site geology presented here is summarized from the *Final Remedial Investigation Report, Woolfolk Chemical Works Site, Fort Valley, Georgia* (CH2M HILL 1992). In general, the uppermost unit of the Fort Valley Plateau is clayey and sandy to pebbly undifferentiated residuum. The residuum is believed to be underlain by undifferentiated Paleocene-Middle Eocene sediments of the Mossy Creek Formation. These sediments are predominantly fine-to-medium grained sands with massive, white to grey, silty-sandy kaolin units. Previous investigations have referred to this unit as the Kaolin Unit, and it is present throughout the WCW Site.

Unconsolidated Upper Cretaceous sediments underlie the undifferentiated Paleocene to Middle Eocene sediments at the WCW Site. This material is believed to be the Gaillard Formation, which contains poorly sorted sands with flakes of muscovite and beds of maroon-stained clay (kaolin), and feathers out in the northwest portion of the WCW Site. The maroon staining may be associated with bioturbation of the sediments; however, differentiation between the three identified Upper Cretaceous units is based on large-scale depositional features such as cross bedding.

Below the Upper Cretaceous are Middle Cretaceous sands and clays that may be the Fort Valley area equivalent of Blufftown and Eutaw Formations. This formation, the Pio Nono Formation, is a part of the Oconee Group and consists of white, yellow, and maroon to light-green clayey sand to sandy clay.

The lowermost geologic unit of interest at the WCW Site is the Tuscaloosa Equivalent. The term Tuscaloosa Equivalent has been adopted because this unit is a facies equivalent of the Alabama-West Georgia Tuscaloosa Formation in the Fort Valley area.

2.1.3.4 Site Hydrogeology

Five main hydrogeologic units have been identified for the WCW Site. The hydrogeologic units generally can be divided into three aquifers and two semi-confining or confining units. They include (in descending order): (1) the surficial aquifer, (2) the Kaolin Semi-Confining Unit, (3) the Upper Cretaceous aquifer, (4) the Middle Cretaceous Confining Unit, and (5) the Tuscaloosa Equivalent. The surficial aquifer is a sandy unit consisting of water that is perched on the Kaolin Semi-Confining Unit.

Groundwater in the surficial aquifer flows generally to the southeast across the facility, following the topography of the underlying (perching) clay unit. Groundwater in the Upper Cretaceous unconfined unit (Horizons 1 and 2) slopes from southwest to northwest with a more easterly component in the southeast part of the facility. Downward leakage is apparent in the western part of the facility. Water levels in this aquifer do not appear to be influenced by pumping in the Tuscaloosa Aquifer from the city water supply wells. Groundwater flow in the Upper Cretaceous Confined Unit (Horizon 3) is generally toward the northeast and east. In the Tuscaloosa Aquifer, groundwater flow is primarily to the southeast, so that the majority of the facility is downgradient of the city water supply wells. Vertical flow is downward. The Upper Cretaceous unconfined and confined aquifers converge toward the northeast.

2.2 Remedial Investigation Results

2.2.1 Phase I Investigation

A total of 352 Phase I surface soil screening samples including 25 duplicates were collected from 327 individual parcels located in the target area and analyzed for arsenic and lead using a graphite furnace with low detection [1 milligram per kilogram (mg/kg)] capabilities.

Arsenic/Lead

Of the 352 Phase I surface soil screening samples, 31 samples were found to be over the risk-based EPA Region 9 preliminary remediation goal (PRG) of 18 mg/kg for arsenic. The distribution of arsenic contamination above the PRG of 18 mg/kg appears to primarily follow the surface water/drainage migration pathway from the main facility southeast along Preston Street and between Preston Street and MLK Jr. Drive extending to the south beyond Lavender Street towards the drainage ditch. The distribution of arsenic contamination also can be attributed to the air migration pathway as PRG exceedences can be found immediately surrounding the site towards the east between MLK Jr. Drive and Oak Street and northeast between Troutman and Church Streets and along Oakland Heights Parkway which are in the direction of the prevailing winds to the east/northeast of the main facility.

A total of seven of the 352 Phase I surface soil samples were found to be over the PRG of 400 mg/kg for lead. The distribution of lead above the PRG of 400 mg/kg appears to be sporadic with a small area concentrated near the downtown area of Fort Valley, Georgia, north of the main facility between East Main and Church Streets. Based on the formal or established waterborne or windborne transport pathway from the main facility, lead PRG exceedences would be expected southeast along Preston Street and to the south beyond Lavender Street towards the drainage ditch or immediately surrounding the site towards the east between MLK Jr. Drive and Oak Street, northeast between Troutman and Church Streets, and along Oakland Heights Parkway. However, the lack of lead PRG exceedences in these areas suggest that the main facility is not the source of lead contamination found in the downtown Fort Valley area between East Main and Church Streets.

2.2.2 Phase II Investigation

A total of 52 Phase II surface soil confirmation samples including 6 duplicates were collected from 46 individual parcels located both inside and outside the target area and analyzed for extractible, metals, pesticides/polychlorinated biphenyls (PCBs), and dioxins/dibenzofurans.

2.2.2.1 Extractables

The most frequently detected extractables were the carcinogenic polycyclic aromatic hydrcarbons (CPAHs), including benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo-a-pyrene, chrysene, and dibenzo(a,h) anthracene.

Of the 52 Phase II surface soil confirmation samples, ten samples had at least one individual CPAH with a concentration exceeding its respective PRGs. In addition, 16 of the 52 Phase II surface soil confirmation samples had total benzo(a)pyrene toxicity equivalent quotient (BAP TEQ) values exceeding the PRG of 62 mg/kg for benzo-a-pyrene. Based on these BAP TEQ PRG exceedences, extractable organic contamination appears to be sporadically distributed outside of the Railroad Street boundary to the north between Railroad Street and Camelia Boulevard, to the west between Central Avenue and College Streets, and to the southwest between Railroad Street and University Drive and away from the OU-3 and OU-4 Sites.

The absence of elevated concentrations of extractables along the water or windblown transport pathways indicate that extractable organic contaminants have not been widely transported from the main facility by either windborne or waterborne transport mechanisms and do not appear to be related to the main facility. Based on waterborne or windborne transport from the main facility, extractable organic contaminant PRG exceedences would be expected southeast along Preston Street and to the south beyond Lavender Street towards the drainage ditch or immediately surrounding the site towards the east between MLK Jr. Drive and Oak Street, northeast between Troutman and Church Streets, and along Oakland Heights Parkway. However, the lack of extractable organic contaminant PRG exceedences in these areas suggest the main facility is not the source of extractable organic contamination found outside of the Railroad Street boundary to the north between Railroad Street and Camelia Boulevard, to the west between Central Avenue and College Streets, and to the southwest between Railroad Street and University Drive. The source of this contamination is unknown.

2.2.2.2 Metals

Arsenic/Lead

Arsenic and lead were the two most frequently detected inorganic contaminants at concentrations above their highest respective background concentrations. Arsenic was found in seven of the 52 Phase II surface soil confirmation samples at concentrations above the PRG of 18 mg/kg. The distribution of arsenic was consistent with the findings of the Phase I surface soil screening investigation. There were no Phase II surface soil confirmation samples that exceeded the PRG of 400 mg/kg for lead.

Other Inorganics

With the exception of arsenic and lead, the other inorganic contaminants detected most frequently at concentrations above their highest respective background concentrations were barium, calcium, copper, magnesium, mercury, and zinc. Isolated PRG or background exceedences also were found for beryllium, cadmium, chromium, nickel, potassium, and sodium; however, based on these exceedences, the distribution of the other inorganic contamination appears to be sporadic and would be difficult to attribute to the main facility.

2.2.2.3 Pesticides/PCBs

The most frequently detected pesticides were the chlorinated hydrocarbon insecticides including 4,4'-DDE, 4,4'-DDT, chlordane, dieldrin, and heptachlor epoxide.

Of the 52 Phase II surface soil confirmation samples, 16 samples had at least one individual concentration value exceeding the constituents respective PRG. Based on these PRG exceedences, the distribution of pesticide contamination appears to be sporadically distributed outside of the Railroad Street boundary to the north between Railroad Street and Camellia Boulevard, to the west/northwest between Camelia Boulevard and Knoxville Street, and to the southwest between Railroad Street and University Drive and away from the OU-3 and OU-4 Sites.

The data indicate that pesticide contaminants have not been widely transported from the main facility by either windborne or waterborne transport mechanisms and do not appear to be related to the main facility. Based on waterborne or windborne transport from the main facility, pesticide PRG exceedences would be expected southeast along Preston Street and to the south beyond Lavender Street towards the drainage ditch or immediately surrounding the site towards the east between MLK Jr. Drive and Oak Street, northeast between Troutman and Church Streets, and along Oakland Heights Parkway. However, the lack of pesticide PRG exceedences in these areas suggest the main facility is not the source of pesticide contamination found outside of the Railroad Street boundary to the north between Railroad Street and Camellia Boulevard, to the west/northwest between Camelia Boulevard and Knoxville Street, and to the southwest between Railroad Street and University Drive. The source of this contamination is unknown.

2.2.2.4 Dioxins/Dibenzofurans

The detected concentrations of the individual dioxin/dibenzofuran isomers for the three surface soil samples collected from the target area were very low level ranging from 0.35 to 980 nanograms per kilogram (ng/kg). The TEQ values for these three samples ranged from 0.046 to 6.6 ng/kg and were well below the EPA residential soil screening value of 1,000 ng/kg.

2.2.3 Attic Dust Investigation

As part of the residential soil removal project, the interiors of a number of homes were cleaned. At that time, it was recognized that the potential existed for contamination of attics by dust from arsenic contaminated soil. The soil removal action impacted 26 homes [U.S. Army Corps of Engineers (USACE) 2002]. In addition to these homes, additional homes were identified as in the potentially contaminated area when applying the site conceptual model airborne transport migration pathway. To characterize the nature and extent of this potential contamination, the following actions were taken.

- Characterization of the dust/arsenic deposition patterns in Fort Valley based upon selected residential attic configurations.
- Characterization of the arsenic contamination levels in Fort Valley residential attics not within the WCW potentially impacted area (i.e., background levels).
- Characterization of the arsenic contamination levels in Fort Valley residential attics within the WCW potentially impacted area.

Four zones were identified (Figure 2-2) for study.

- **Zone I** includes all homes located north-northeast (NNE) of the former WCW production site. This includes homes located on MLK Drive (Main Street), Fagan Street, Oak Street, and Troutman Street.
- **Zone II** includes all homes located south-southwest (SSW) of the former WCW production site. This includes homes located on Preston Street, Elm Street, Beach Street, and Chestnut Street.
- **Zone III** includes all homes located west (W) of the former WCW production site. This includes homes located on Pine Street and O'Neal Street.
- **Zone IV** includes all homes within the reference area (southwest of the former WCW production site) (USACE 2002).

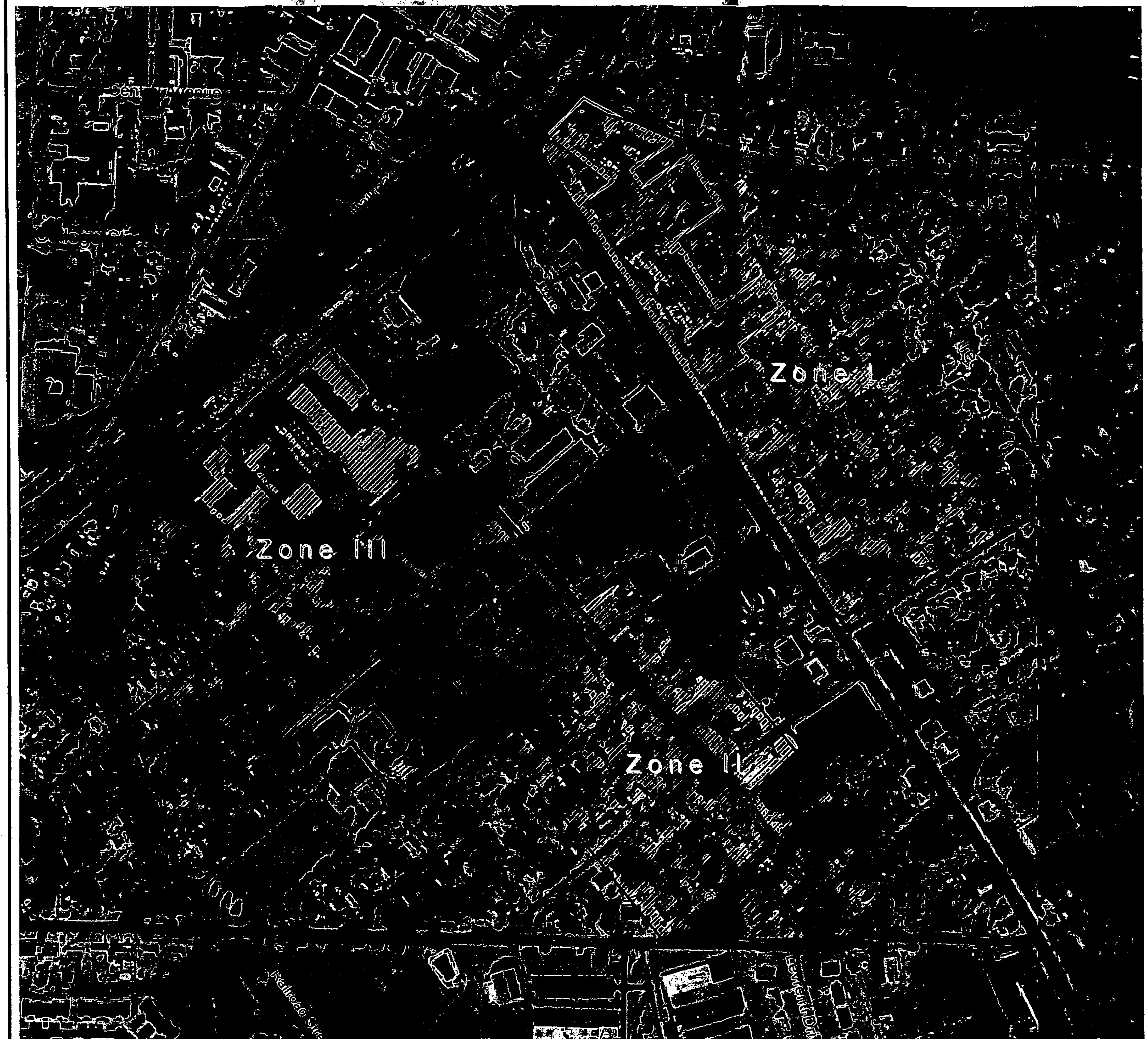

Figure 2-2
Attic Dust Sampling Zones
Woolfolk Chemical Works Site OU4 RI/FS
Fort Valley, Georgia

Legend

- Operable Unit 2 Boundary
- Operable Unit 3 Boundary
- Attic Dust Study Zones

CDM

Map Filename: figure2-2FS_ZoneLocationMap.mxd 06/12/2002

As indicated in Table 2-1, the average dust concentration within the attics of the target homes is approximately 70 percent higher than the average reference area (background) concentration. This is believed to be related to higher ambient air dust levels due to the proximity to high traffic areas and local vegetation differences. The study showed that there is a general west to east wind direction component to the dust patterns and the highest dust levels occur away from the ridge line near the soffit edge of the house. The exact maximum deposition point varies depending on details of the attic configuration and lot factors (e.g., adjacent trees, roof geometry) (USACE 2002).

Table 2-1
Target and Reference Data Summary
Woolfolk Chemical Works Site, OU-4, Fort Valley, Georgia

	Avg dust (mg/100 cm^2)			Arsenic (mg/kg)			Arsenic loading (µg/100 cm^2)
Type	Min	Max	Avg	Min	Max	Avg	Avg
Target	0.8	1268.7	189.1	0.7	1194.5	157.7	29.81
Reference	2.9	676.0	113.4	1.4	70.7	14.9	1.70
T/R ratio			1.7			10.5	17.6

According to the study results, arsenic levels in the attics appear to be ventilation type dependent. Levels tend to be highest away from the ridge line near the soffit edge. For soffit houses, there is minimal dust intrusion so arsenic concentration differences in target versus reference homes are minimal. For gable houses, attic arsenic levels higher in target homes than reference homes (USACE). Concentrations tend to be higher near the center than at the gable and higher near the soffit edge than the ridge line. Within the attic there are minimal differences in attic arsenic levels at various horizontal strata (top of insulation versus under insulation) (USACE 2002).

Based on the information summarized above, it was determined that all homes in the target should be sampled. All homes initially identified as potentially affected were sampled at locations based on the model home sampling results. A second mobilization was conducted in the potentially affected area to sample additional homes not originally identified and tested, but were determined to be within the potentially affected area based on the results of the first mobilization. Unlike the model home task sampling, which was designed to select sampling locations, the purpose of this task was to determine whether an individual home attic had elevated levels of arsenic when compared to a regulatory value, a reference area value, and/or a risk-based criteria (USACE 2002).

2.2.4 RI Conclusion

2.2.4.1 Surface Soil Investigation

In summary, a review of the OU-4 RI results along with results from previous investigations clearly indicate that the most significant surface soil inorganic contamination is arsenic and that it follows both the surface water runoff/drainage migration pathway primarily to the south of the former facility (OU-3) and the windborne migration pathway immediately surrounding the main facility and to the east and northeast of the main facility in the direction of the prevailing winds. The main facility does not appear to be the source of the extractable organic, pesticide, or with the exception of arsenic, other inorganic contamination..

2.2.4.2 Attic Dust Investigation

Attic arsenic levels at certain homes in the target area are significantly greater than would be anticipated based on the levels found in the reference area. Arsenic and dust levels vary spatially within attics. This variance appears to be related to attic ventilation type. Ventilation type would impact turbulence in the attic and this results in settling patterns consistent with the particle size and density (USACE 2002).

Although other sources may exist, the use of arsenic at the WCW Site would appear to be the most likely explanation for elevated arsenic levels in the attics of homes located in the target area. The study indicated that there is not an imminent health risk threat to any resident based on the attic use patterns stated by the current residents in the home survey (USACE 2002). Long-term health risk from arsenic exposure could occur if exposure patterns change in the future or if a resident where to enter their attic more often than once per month average. Homes with arsenic concentrations greater than 1,000 mg/kg would exceed the typical CERCLA action levels [incremental lifetime cancer risk (ILCR) >10^{-4} and noncarcinogenic hazard index (HI) >3] if exposure frequency was greater than once per month (USACE 2002).

2.3 Summary of Human Health Risk Assessment

To characterize the overall potential for noncarcinogenic effects associated with exposure to multiple chemicals, EPA uses an HI approach. This approach assumes that simultaneous subthreshold chronic exposures to multiple chemicals that affect the same target organ are additive and could result in an adverse health effect.

Calculation of an HI in excess of unity indicates the potential for adverse health effects. Indices greater than one will be generated anytime intake for any of the contaminants of potential concern (COPCs) exceeds its reference dose (RfD).

However, given a sufficient number of chemicals under consideration, it is also possible to generate an HI greater than one even if none of the individual chemical intakes exceeds its respective RfD.

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. This is also referred to as incremental or excess individual lifetime cancer risk. These risks are probabilities that are generally expressed in scientific notation (i.e., 1×10^{-6} or 1E-6). An incremental lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper-bound, an individual has a one-in-one-million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at the site. For exposures to multiple carcinogens, EPA assumes that the risk associated with multiple exposures is equivalent to the sum of their individual risks.

Soil

Exposure routes potentially complete are:

- inadvertent ingestion of soil,
- dermal contact with soil, and
- inhalation of dust.

For five residential parcels, F26-148, F37-83, F37-95, F38-133, and F46-1, EPA's target range for Superfund sites was exceeded. The principal soil contaminant for parcels F37-83, F37-95, F38-133, and F46-1 was arsenic, found at 27, 21, 23, and 30 mg/kg, respectively. The principal soil contaminant in parcel F26-148 was dieldrin which was found at 5.4 mg/kg.

Parcel-specific arsenic and lead results based on CGC 1998 data combined with the CDM Phase I data indicated sixteen of 327 properties had soil arsenic concentrations above 20 mg/kg. Arsenic above 20 mg/kg yields a HI greater than 1 for a child resident. This is above the acceptable range for Superfund sites.

Lead concentrations above 400 mg/kg exceed EPA's residential screening level for lead (EPA 1994 and 1998). Screening levels are concentrations of contamination above which there may be enough concern to warrant a site-specific study of risk. Seven of 324 properties had soil lead concentrations above the screening level. Note: the screening levels cited for arsenic and lead are applicable to residential land use. Screening levels for commercial/industrial land use would be higher.

None of the commercial properties had an excess cancer risk or HI above EPA's target range for Superfund sites. Note: both excess cancer risk and noncancer hazards were calculated for site worker receptors.

In the future, commercial/industrial properties may be redeveloped for residential use. Potential receptors would be residents. Potentially complete exposure routes for residents exposed to contaminated soil are the same:

- inadvertent ingestion of soil,
- dermal contact with soil, and
- inhalation of dust.

Using residential land use assumptions, parcel F38-66B exceeds EPA's target range for Superfund site in that the calculated HI is greater than 1. The principal contaminant was chlordane, present as alpha-chlordane at 24 mg/kg, and as chlordane at 23 mg/kg. The excess cancer risk was 1×10^{-4}, which is within EPA's target range. When residential land use exposure assumptions were applied to the remaining nine properties, the excess cancer risk and HIs were within EPA's acceptable target ranges (CDM 2001b).

The baseline risk assessment (BRA) defined contaminants of concern (COCs) for the site by identifying the most significant contaminants in an exposure scenario that exceeds an excess cancer risk level of 1E-4 or an HI of 1. More specifically, COCs have individual excess cancer risk levels of 1E-6 or a hazard quotient (HQ) of 0.1 in a given exposure scenario.

The BRA then calculated remedial goal options (RGOs) by combining the intake levels of each COC from all appropriate exposure routes for a particular medium and rearranging the risk equations to solve for the concentration term. RGOs provide remedial design staff with long-term targets to use during analysis and selection of remedial alternatives. Ideally, such goals, if achieved, will comply with ARARs and result in residual risks that fully satisfy the National Contingency Plan (NCP) requirements for the protection of human health and the environment. Risk-based RGOs are guidelines and do not establish that cleanup to meet these goals is warranted. Risk-based RGOs were calculated for both cancer and noncancer effects for the COCs in surface soil, surface water, and groundwater at the WCW OU-4 Site. Incremental cancer and noncancer risk RGOs for each scenario are presented in Table 2-2.

Attic Dust

The risk associated with a particular concentration is related to three main factors: (1) the exposure point concentration, (2) a set of exposure factors, and (3) toxicity

Table 2-2
Risk-Based Remedial Goal Options for Surface Soil
Residential Land Use Assumptions
Woolfolk Chemical Works Site OU4

Chemicals of Concern	Detections [1] mg/kg		Cancer Risk Level [2] mg/kg			Hazard Quotient Level [3] mg/kg		
	Min	Max	1E-6	1E-5	1E-4	HQ = 0.1	HQ = 1	HQ = 3
Arsenic [4]	0.6	120	0.3	3	30	2	20	60
Iron	1,700	19,000	NA	NA	NA	2,200	22,000	66,000
Lead [4]	3.8	4,000	NA	NA	NA	NA	NA	NA
Manganese	25	2,400	NA	NA	NA	400	4,000	12,000
Alpha-Chlordane	0.023	24	1	10	100	3	30	90
Chlordane	0.00046	23	1	10	100	3	30	90
Dieldrin	0.0016	5.4	0.03	0.3	3	0.3	3	9

Notes:

1. Minimum/maximum detected concentration in Phase II samples: 101-SSD through 103-SSD, 111-SS through 122-SS, SS2-201 through SS2-219, and SS2-301 through SS2-319.

2. Remediation goals based on oral, inhalation and dermal contact using adult / child resident land use exposure assumptions.

3. Remediation goals based on oral, inhalation and dermal contact using child resident land use exposure assumptions.

4. Includes CGC 1998 and Phase I data.

Acronyms:

NA: Not applicable

HQ: Hazard quotient (noncancer risk)

factors. In this case of attic dust, the exposure factors can vary greatly between residents and also between current and future residents based on attic use. Table 2-3 summarizes the risk associated with various concentrations using combinations of attic exposure factors for both carcinogenic and noncarcinogenic effects (USACE 2002). The arsenic level in certain homes would exceed the typical CERCLA action levels (ILCR >10^{-4} and HI >3) for certain homes with arsenic concentrations greater than 1,000 mg/kg if exposure frequency was greater than once per month.

According to the results of the home survey conducted as part of the attic dust investigation, most residents do not use their attics on a regular basis. Typical entry consists of entry a few times a year (e.g., 1-3) to place or retrieve items stored in the attic. No residents indicated entry for extended periods of time or on a frequent basis (e.g., weekly for several hours) (USACE 2002).

2.4 Summary of Screening-Level Ecological Risk Assessment

Several COPCs in soil were defined for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) and pesticides either because HQs were greater than one or because no Region 4 screening-level bench mark values were available. The screening-level ecological risk assessment (SERA) demonstrates the potential for risk to ecological receptors from exposure to the drainage ditch located and recommends a meeting to initiate development of the problem formulation phase for a baseline ecological risk assessment.

2.5 Contaminant Fate and Transport

The transport and fate of chemicals in the environment is largely a function of their physical properties, the physical properties of the surrounding matrix, the physical conditions to which they are subjected, and chemical factors. Because hazardous properties of chemicals may be altered by various environmental factors, it is helpful to understand the behavior of released chemicals in the environment in order to assess the potential for exposure to them. A consideration of contaminant fate and transport at the WCW OU-4 Site is useful because the results of the RI indicate that soil contamination may impact human health.

Potential mechanisms available for contaminant transport away from the WCW facility to the OU-4 Site and away from the WCW OU-4 Site include:

- air /volatilization
  /fugitive dust generation

Table 2-3. Attic Dust Summary of Risk

Evaluation of various exposure frequencies and target cancer risk on threshold contaminant level

Table 1a. Cancer Risk - Arsenic

PEF - Particulate Emission Factor, EF - Exposure Frequency, MDC - Maximum Detected Concentration

Source: USACE, 2002.

		Exposure Scenario			
PEF	Description	yearly	monthly	weekly	daily
1.316E+09	EF (day/yr)	1	12	52	350
TR - Target cancer risk	1.00E-04	13636.06	1136.34	262.23	38.96
	1.00E-05	1363.61	113.63	26.22	3.90
	1.00E-06	136.36	11.36	2.62	0.39

		Exposure Scenario			
PEF	Description	yearly	monthly	weekly	daily
1.316E+09	EF (day/yr)	1	12	52	350
THQ - Target	0.1	809.91	68.36	15.79	2.35
Hazard Quotient	1.0	8099.11	683.58	157.89	23.46
(No-Cancer Risk)	3.0	24297.34	2050.73	473.67	70.39

Table 1b. EPA Region 9 PRGs	soil - inhale	soil - dermal	soil - ingest	soil - combined	Cancer Risk = 1E-06
	590.00	4.50	0.43	0.39	

Table 2a. Cancer Risk using scenarios noted and given concentrations

		Exposure Scenario			
	Description	yearly	monthly	weekly	daily
	mg/kg	1 day/yr	12 days/yr	52 days/yr	350 days/yr
background soil average	2.70	1.98E-08	2.38E-07	1.03E-06	6.93E-06
	5.00	3.67E-08	4.40E-07	1.91E-06	1.28E-05
	10.00	7.33E-08	8.80E-07	3.81E-06	2.57E-05
mean reference attic As level	14.90	1.09E-07	1.31E-06	5.68E-06	3.82E-05
	18.00	1.32E-07	1.58E-06	6.86E-06	4.62E-05
	20.00	1.47E-07	1.76E-06	7.63E-06	5.13E-05
	25.00	1.83E-07	2.20E-06	9.53E-06	6.42E-05
	30.00	2.20E-07	2.64E-06	1.14E-05	7.70E-05
	39.00	2.86E-07	3.43E-06	1.49E-05	1.00E-04
MDC from reference set	70.70	5.18E-07	6.22E-06	2.70E-05	1.81E-04
	100.00	7.33E-07	8.80E-06	3.81E-05	2.57E-04
Average target area model home	157.00	1.15E-06	1.38E-05	5.99E-05	4.03E-04
	250.00	1.83E-06	2.20E-05	9.53E-05	6.42E-04
	500.00	3.67E-06	4.40E-05	1.91E-04	[illegible]
	750.00	5.50E-06	6.60E-05	2.86E-04	[illegible]
	1000.00	7.33E-06	8.80E-05	3.81E-04	[illegible]
	1250.00	9.17E-06	1.10E-04	4.77E-04	[illegible]
	1500.00	1.10E-05	1.32E-04	5.72E-04	[illegible]
	1750.00	1.28E-05	1.54E-04	6.67E-04	[illegible]
	2000.00	1.47E-05	1.76E-04	7.63E-04	[illegible]
	2250.00	1.65E-05	1.98E-04	8.58E-04	[illegible]
	2500.00	1.83E-05	2.20E-04	9.53E-04	[illegible]

Table 2b. Non-Cancer Risk using scenarios noted and given concentrations

		Exposure Scenario			
	Description	yearly	monthly	weekly	daily
	mg/kg	1 day/yr	12 days/yr	52 days/yr	350 days/yr
background soil average	2.70	0.000	0.004	0.017	0.115
	5.00	0.001	0.007	0.032	0.213
	10.00	0.001	0.015	0.063	0.426
mean reference attic As level	14.90	0.002	0.022	0.094	0.635
	18.00	0.002	0.026	0.114	0.767
	20.00	0.002	0.029	0.127	0.852
	25.00	0.003	0.037	0.158	1.065
	30.00	0.004	0.044	0.190	1.279
	39.00	0.005	0.057	0.247	1.662
MDC from reference set	70.70	0.009	0.103	0.448	3.013
	100.00	0.012	0.146	0.633	[illegible]
Average target area model home	157.00	0.019	0.230	0.994	[illegible]
	250.00	0.031	0.366	1.583	[illegible]
	500.00	0.062	0.731	[illegible]	[illegible]
	750.00	0.093	1.097	[illegible]	[illegible]
	1000.00	0.123	1.463	[illegible]	[illegible]
	1250.00	0.154	1.829	[illegible]	[illegible]
	1500.00	0.185	2.194	[illegible]	[illegible]
	1750.00	0.216	2.560	[illegible]	[illegible]
	2000.00	0.247	2.926	[illegible]	[illegible]
	2250.00	0.278	[illegible]	[illegible]	[illegible]
	2500.00	0.309	[illegible]	[illegible]	[illegible]

- soil /leaching
  /surface runoff
  /episodic overland flow
  /fugitive dust generation/deposition

- biota /uptake

Primary considerations in contaminant transport include transport by rainwater runoff and rainwater infiltration into groundwater.

In addition to rainwater runoff, rain falling directly on-site or as runon to the site moves through contaminated soils, picking up soluble contaminants, such as metals, and during periods of heavy rainfall, moves sediments containing contaminants. The rainwater can then enter groundwater via infiltration.

A final consideration in examining fate and transport of contaminants at a site is the examination of the physical properties of some of the individual COCs defined for a site. To do this, it is helpful to first define the factors describing the physical properties that affect fate and transport. These properties are defined below:

- **Adsorption** – the process by which a gas, vapor, dissolved material, or very small particle adheres to the surface of a solid. The attraction and adhesion of ions from an aqueous solution to the solid soil or rock surfaces with which they are in contact. Adsorption can be measured as:

  – **Organic Carbon/Water Partition Coefficient (K_{oc})** – K_{oc} provides a measure of the extent of chemical partitioning between organic carbon and water at equilibrium. The higher the K_{oc}, the more likely a chemical is to bind to soil or sediment than to remain in water.

  – **Soil/Water Partition Coefficient (K_d)** – K_d provides a soil or sediment-specific measure of the extent of chemical partitioning between soil or sediment and water. The higher the K_d, the more likely a chemical is to bind to soil or sediment than to remain in the water.

- **Volatilization** – the passing of a solid or liquid material into a vapor state at a given temperature. The volatilization of a compound depends on its vapor pressure, water solubility, and diffusion coefficient. The Henry's Law Constant (H) combines vapor pressure with solubility to provide a measure of the extent of chemical partitioning between air and water at equilibrium. Compounds with H values greater than $10^{-3}m^3$/mole can be expected to volatilize readily from water; those with values ranging from 10^{-3} to 10^{-5} are associated with possibly significant but not facile volatilization, and compounds with values less than 10^{-5} will volatilize from water only to a limited extent. Site-specific conditions affecting volatilization rates include temperature, wind velocity, soil porosity and water content, soil organic carbon, depth of contamination, and the presence of other constituents in the matrix.

- **Solubility** – the ability or tendency of one substance to blend uniformly with another. The octanol-water partition coefficient (K_{ow}) is a coefficient representing the ratio of solubility of a compound in a nonpolar substance (octanol) to its solubility in a relatively polar substance (water). As K_{ow} increases, water solubility decreases, as does mobility in a groundwater system.

The physical properties of a COC, along with the physical/chemical properties of the soil, such as permeability, porosity, particle size distribution, and organic carbon content, along with possible transformation reactions that may occur in the environment including biodegradation, photolysis, hydrolysis, oxidation and reduction, neutralization, polymerization, and ion exchange all impact the potential for exposure to receptors.

For the WCW OU-4 Site, the RI indicates that arsenic is the primary COC related to past Main facility activities.

Arsenic

Arsenic in soil exists in various oxidation states and chemical species, depending upon soil pH and redox potential. Arsenate [(As(V)] and arsenite [As(III)] exist as oxyanions in oxidized systems, while metallic arsenic [As(0)], arsine [As(-III)] and methylated forms of arsenic are thermodynamically stable in reduced systems such as swamp and bogs. The arsenate and arsenite oxyanions can have various degrees of protonation depending upon pH (EPA 1982a, McGeehan 1996). As(V) predominates in aerobic soils, and As(III) predominates in slightly reduced soils (e.g., temporarily flooded) (EPA 1982a). Transformations between the various oxidation states and species of arsenic occur upon the arsenic species and the oxidation state. Arsenite is of environmental concern because it is much more toxic than arsenate and is much more mobile in soil systems (McGeehan 1996). Organoarsenical pesticides [e.g., methylamine (MMA), 2,4-dimethylamine (DMA)] applied to soil are metabolized by soil bacteria to alkylarsines, arsenate, and MMA. Arsenicals can also be mineralized to inorganic arsenic; however, as previously mentioned, the interconversion of the various arsenic species and transport among the environmental media is complex and not all aspects are well-studied.

Arsenic in water can undergo a complex series of transformations, including oxidation-reduction reactions, ligand exchange, and biotransformation (Callahan et al. 1979, EPA 1984, Welch et al. 1988). Rate constants for these various reactions are not readily available, but the factors most strongly influencing fate processes in water include Eh (the oxidation-reduction potential), pH metal sulfide and sulfide ion concentrations, iron concentrations, temperature, salinity, and distribution and composition of the biota (Callahan et al. 1979, Wakao et al. 1988). No formation of arsine gas from marine environments has been reported (Tamaki and Frankenberger 1992).

In aquatic systems, inorganic arsenic occurs primarily in two oxidation states, As (V) and As (III) oxidation states are considered more toxic to humans than the As (V) state (Aurillo et al. 1994). In general As(V) predominates under oxidizing conditions and As(III) predominates under reducing conditions; however, the reduction of arsenate to arsenite is slow so arsenate can be found in reducing environments. Conversely, arsenite can be found in oxidizing environments (Mariner et al. 1996). In the pH range of natural waters, the predominant aqueous arsenate species are $H_2SO_4^-$ and $HAsO_4^{2-}$. The predominant arsenite species is H_3AsO_3 (Aurillo et al. 1994). The predominant form of arsenic in surface waters is usually arsenate (EPA 1982b), but aquatic microorrganisms may reduce the arsenate to arsenite and a variety of methylated arsenicals (Aurillo et al. 1994, Benson 1989, Braman et al. 1977, Edmonds and Francesconi 1987, Gao and Burau 1997). Both reduction and methylation of As(V) may lead to increased mobilization of arsenic, since As(III), dimethylarsinates, and monomethylarsonates are much less particle-reactive than As(V) (Aurillo et al. 1994). Arsenate often predominates in groundwater, but arsenite may be an important component, depending upon the characteristics of the water and surrounding geology (Robertson 1989, Welch et al. 1988).

2.6 Applicable or Relevant and Appropriate Requirements

As required under Section 121 of CERCLA, remedial actions carried out under Section 104 or secured under Section 106 must be protective of human health and the environment and attain the levels or standards of control for hazardous substances, pollutants, or contaminants specified by the ARARs of federal environmental laws and state environmental and facility siting laws, unless waivers are obtained. According to EPA guidance, remedial actions also must take into account nonpromulgated "to be considered" criteria or guidelines if the ARARs do not address a particular situation.

The requirement that ARARs be identified and complied with and the development and implementation of remedial actions is found in Section 121(d)(2) of CERCLA [United States Code (USC) Section 9621(d)(2)]. Section 121(d)(2) requires that, for any hazardous substance remaining on-site, all federal and state environmental and facility siting standards, requirements, criteria, or limitations shall be met at the completion of the remedial action to the degree that those requirements are legally applicable or appropriate and relevant under the circumstances present at the site.

The degree to which these environmental and facility siting requirements must be met varies, depending on the applicability of the requirements. Applicable requirements must be met to the full extent required by law. CERCLA provides that permits are not required when a response action is taken "on-site." The NCP defines the term "on-site" as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action" [40 *Code of Federal Regulations* (CFR) 300.5]. Although permits are not required, the substance of the applicable permits must be met. On the other hand, only the relevant and appropriate portions of non-applicable requirements must be achieved, and only to the degree that they are substantive rather than administrative in nature.

2.6.1 Definition of ARARS

A requirement under CERCLA, as amended, may be either "applicable" or "relevant and appropriate" to a site-specific remedial action, but not both. The distinction is critical to understanding the constraints imposed on remedial alternatives by environmental regulations other than CERCLA.

Applicable Requirements

Applicable requirements pertain to those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Applicable requirements are defined in the NCP, at 40 CFR 300.5 – Definitions.

Relevant and Appropriate Requirements

Relevant and appropriate requirements pertain to those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental, state environmental, or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site per se, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate. Relevant and appropriate requirements are defined in the NCP, at 40 CFR 300.5—Definitions.

Other Requirements to Be Considered

These requirements pertain to federal and state criteria, advisories, guidelines, or proposed standards that are not generally enforceable but are advisory and that do not have the status of potential ARARs. Guidance documents or advisories "to be considered" in determining the necessary level of remediation for protection of human health or the environment may be used where no specific ARARs exist for a chemical or situation, or where such ARARs are not sufficient to be protective.

Waivers

Superfund specifies situations under which the ARARs may be waived (40 CFR 300.430: Remedial Investigation/Feasibility Study (f) Selection of Remedy). The situations eligible for waivers include:

- the alternative is an interim measure and will become part of a total remedial action that will attain the applicable or relevant and appropriate federal or state requirement;

- compliance with the requirement will result in greater risk to human health and the environment than other alternatives;

- compliance with the requirement is technically impracticable from an engineering perspective;

- the alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, or limitation through use of another method or approach;

- with respect to a state requirement, the state has not consistently applied, or demonstrated the intention to consistently apply, the promulgated requirement in similar circumstances at other remedial actions within the state; or
- for Fund-financed response actions only, an alternative that attains the ARAR will not provide a balance between the need for protection of human health and the environment at the site and the availability of Fund monies to respond to other sites that may present a threat to human health and the environment.

Where remedial actions are selected that do not attain ARARs, the lead agency must publish an explanation in terms of these waivers. It should be noted that the "fund balancing waiver" only applies to Superfund-financed remedial actions.

ARARs apply to actions or conditions located on-site and off-site. On-site actions implemented under CERCLA are exempt from administrative requirements of federal and state regulations, such as permits, as long as the substantive requirements of the ARARs are met. Off-site actions are subject to the full requirements of the applicable standards or regulations, including all administrative and procedural requirements.

Based on the CERCLA statutory requirements, the remedial actions developed in this FS will be analyzed for compliance with federal and state environmental regulations. This process involves the initial identification of potential requirements, the evaluation of the potential requirements for applicability or relevance and appropriateness, and finally a determination of the ability of the remedial alternatives to achieve the ARARs.

2.6.2 Identification of ARARS

Three classifications of requirements are defined by EPA in the ARAR determination process.

- Chemical-specific – requirements that set protective remediation goals (RGs) for the COCs.
- Location-specific – requirements that restrict remedial actions based on the characteristics of the site or its immediate surroundings.
- Action-specific – requirements that set controls or restrictions on the design, implementation, and performance levels of activities related to the management of hazardous substances, pollutants, or contaminants.

Chemical-specific ARARs include those laws and regulations governing the release of materials possessing certain chemical or physical characteristics, or containing specified chemical compounds. Chemical-specific requirements set health- or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, contaminants, and pollutants. These requirements provide protective site remediation levels as a basis for calculating RGs for the COCs in the designated media. Examples include drinking water standards and ambient air quality standards. Chemical-specific ARARs can be established once the nature of the contamination at the site has been defined, which is accomplished during the RI phase.

Location-specific ARARs are design requirements or activity restrictions based on the geographical or physical positions of the site and its surrounding area. Location-specific requirements set restrictions on the types of remedial activities that can be performed based on site-specific characteristics or location. Examples include areas in a floodplain, a wetland, or a historic site. Location-specific criteria can generally be established early in the RI/FS process since they are not affected by the type of contaminant or the type of remedial action implemented. Location-specific ARARs for the WCW OU-4 Site were evaluated and consisted of location standards for work in a floodplain, protection of endangered species, fish and wildlife coordination, archeological and historical preservation, protection of wetlands, and guidelines for dredged or fill material placement. Location-specific ARARs should be re-evaluated during the design phase.

Action-specific ARARs are technology-based, establishing performance, design, or other similar action-specific controls or regulations for the activities related to the management of hazardous substances or pollutants. Action-specific requirements are triggered by the particular remedial action alternatives that are selected to accomplish the cleanup of hazardous wastes. An example includes Resource Conservation and Recovery Act (RCRA) incineration regulations. Federal and State ARARs for the WCW OU-4 Site are listed in Tables 2-4 and 2-5.

2.7 Remedial Goals for Contaminants of Concern

As previously indicated, general RGOs were developed for the protection of human health based on the results of the BRA. Incremental cancer and noncancer risk for each scenario are presented in Table 2-2. Note that arsenic is a natural occurring mineral that is considered by EPA to be a systemic toxicant and a human carcinogen. However, there is considerable uncertainty concerning its ability to cause cancer at low exposure levels, especially the less soluble form that occurs in contaminated soil. The Superfund program of Region 4 regulates arsenic in soil as a systemic toxicant (noncarcinogen) in deriving RGs. As an additional precaution, EPA also requires soil clean up levels to fall within the most protective cancer risk range of 1E-4 to 1E-6 for the most sensitive likely receptor even though the calculated risk may be significantly over predictive of risk.

By considering past site operations, identifying COC contamination in OU-4 soils that most likely stems from OU-3 historical activities, and the various surface-soil risk-based RGOs that are available, list of surface soil RGs applicable to the WCW OU-4 Site can be developed. For WCW OU-4, arsenic is the only COC

Table 2-4
Summary of Potential Federal Applicable or Relevant and Appropriate Requirements
Woolfolk OU4 Site

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Contaminant-Specific			
Clean Air Act	42 USC § 7409		
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Air quality levels that protect public health	Applicable
Resource Conservation and Recovery Act			
Identification and Listing of Hazardous Waste	40 CFR Parts 262-265 and Parts 124, 270, and 271	Defines those solid mining-related wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265, 124, 270, and 271	Applicable
Clean Water Act	33 USC § 1251-1376		
NPDES	40 CFR Part 122	General permits for discharge from construction	Relevant and Appropriate
Dredge and Fill Requirements [Section 404(b)(1)]	40 CFR Part 230	Action to prohibit discharge of dredged or fill material into wetland without permit.	Relevant and Appropriate
Location-Specific			
National Historic Preservation Act	16 USC § 470; 36 CFR Part 800	Requires federal agencies to take into account the effect of any federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in, or eligible for, inclusion in the National Register of Historic Places (NRHP).	Applicable, if any NRHP objects are on or adjacent to site.

Table 2-4 (continued)

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant *and* Appropriate
Archeological and Historic Preservation Act	16 USC § 469; 40 CFR § 6.301(c)	Establishes procedures to preserve historical and archeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	Applicable
Floodplain Management Executive Order	Executive Order 11988	Action to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values of the floodplain.	Applicable, if site falls within floodplain
Wetlands Management Executive Order	Executive Order 11990	Action to minimize the destruction, loss or degradation of wetlands.	Applicable
Protection of Wetlands and Floodplains	40 CFR Part 6, Appendix A	Contains EPA's regulations for implementing Executive Orders 11988 and 11990.	Applicable
Historic Sites, Buildings and Antiquities Act	16 USC §§ 461-467; 40 CFR § 6.301(a)	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks	Applicable, if any landmarks are present.
Endangered Species Act	16 USC §§ 1531; 40 CFR Part 6.302; 50 CFR Part 402	Requires action to conserve endangered species within critical habitat upon which species depend; includes consultation with the Department of the Interior	Applicable
Fish and Wildlife Coordination Act	16 USC §§ 661-666c	Any federal agency which proposes or authorizes a modification to a stream, or water body which may affect fish and wildlife must consult with the Fish and Wildlife Service. This act requires protection of fish and wildlife resources.	Applicable

Table 2-4 (continued)

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Migratory Bird Treaty Act of 1973	16 USC §§ 703	Established a prohibition, unless permitted, to pursue, hunt, capture, kill, or take any migratory bird or attempt any of these actions. Also protects migratory birds in their environments.	Applicable
Emergency Wetlands Resources Act of 1986	16 USC §§ 3901	Requires the Secretary to establish a National Wetlands Priority Plan and report to Congress on the loss of wetlands including the role federal agencies have in the loss of these wetlands.	Applicable
U.S. Fish and Wildlife Service Mitigation Policy	NPI#89-02	Provides for the policy to develop consistent and effective recommendations to protect and conserve natural resources. Also allows federal and private developers to incorporate mitigation measures into the early stages of planning.	Applicable
National Environmental Policy Act of 1969	16 USC §§ 4331 40 CFR Part 1501	Requires federal agencies to prepare comprehensive environmental impact statements for every recommendation on proposals for legislation and federal actions which might significantly affect the quality of the environment.	Applicable
Resource Conservation and Recovery Act	40 CFR Part 264	Requires hazardous waste facilities to be (1) located at least 200 feet from a fault and (2) designed to withstand a 100-year flood if located in the 100-year flood plain.	Applicable
Action-Specific			
Hazardous Materials Transportation Act			
Hazardous Materials Transportation Regulations	49 CFR Parts 10, 171-177	Regulates transportation of hazardous materials, including mining wastes that are not exempt under the Bevill Amendment	Applicable

Table 2-4 (continued)

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Resource Conservation and Recovery Act			
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment and thereby constitute prohibited open dumps	Relevant and Appropriate
Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263	Establishes standards that apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR Part 262	Applicable
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR Part 264	Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste	Relevant and Appropriate
Clean Water Act	33 USC § 1342		
NPDES	40 CFR Part 122	Requires permits for the discharge of pollutants from any point source into waters of the United States	Relevant and Appropriate
Dredge and Fill Requirements [Section 404(b)(1)]	40 CFR Part 230	Action to prohibit discharge of dredged or fill material into wetland without permit.	Relevant and Appropriate
Occupational Safety and Health Administration Requirements	29 CFR 1910	Establishes requirements for workers at remedial action sites. Any remedial action on-site must be performed in accordance with applicable OSHA standards.	Applicable

TABLE 2-5
Summary of Potential State Applicable or Relevant and Appropriate Requirements
Woolfolk OU4 Site

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Contaminant-Specific			
Hazardous Sites Response	GA Chapter 391-3-19	Establishes policies, procedures, requirements, and standards to implement the Georgia Hazardous Site Response Act (O.C.G.A. 12-8-90). In particular, Chapter 391-3-19-.07 establishes the risk reduction standards.	Applicable
Air Quality Control	GA Chapter 391-3-1	Establishes the policies, procedures, requirements, and standards to implement the Georgia Air Quality Control Law (O.C.G.A. Section 12-9-1). States that no person shall construct or operate any facility from which air contaminants may be emitted in such a manner as to fail to comply with any applicable standards of performance or any other requirement for a hazardous air pollutant established by EPA.	Relevant and Appropriate for handling of contaminated soil and soil /groundwater treatment at the site.
Location -Specific			
Erosion and Sedimentation Control	GA Chapter 391-3-7	Establishes the requirements for obtaining a permit before any land disturbing activity is undertaken. A plan must be developed before any land disturbance. In addition, any land disturbing activity proposed within a 100-year floodplain must not adversely affect adjacent upstream or downstream properties by causing flooding, erosion, or sedimentation.	Relevant and Appropriate
Rules for Environmental Planning Criteria	GA Chapter 391-3-16	Establishes criteria for the protection of groundwater recharge areas and wetlands.	Relevant and Appropriate

TABLE 2-5 (Continued)
Summary of Potential State Applicable or Relevant and Appropriate Requirements
Woolfolk OU4 Site

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Game and Fish	O.C.G.A. Section 27	Wildlife species identified as endangered or threatened will be protected from harm, and that the disturbance, mutilation, or destruction of wildlife homes is prohibited.	Relevant and Appropriate
Endangered Wildlife & Windflower Preservation Acts of 1973	GA Code 12-6-172	Protection of endangered or threatened species that are state listed and not federally listed, or are more stringently listed by the state act than the federal act.	Relevant and Appropriate
Criteria for Siting Solid Waste Handling Facility	GA Chapter 391-3-4-.05	Provides criteria that must be met for a site proposed as a solid waste handling facility. Defines requirements and restrictions for sites proposed for 100-year floodplain areas, wetlands, fault areas, seismic impact zones, and significant groundwater recharge areas.	Applicable
		Action-Specific	
Hazardous Waste Management	GA Chapter 391-3-11	Establishes policies, requirements and standards to implement the Georgia Hazardous Waste Management Act (O.C.G.A. 12-8-60). Promulgated for the purpose of protecting and enhancing the quality of the State's environment and protecting the public health, safety, and well-being of its citizens. Subparagraphs within this rule include 391-3-10-.04 (notification of hazardous waste activities), 391-3-10-.07 (identification and listing of hazardous waste), and 391-3-10-.11 (hazardous waste facility permits).	Relevant and Appropriate

TABLE 2-5 (Continued)
Summary of Potential State Applicable or Relevant and Appropriate Requirements
Woolfolk OU4 Site

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate
Transportation of Hazardous Materials	GA Chapter 672-10	Establishes the requirements for the transportation of hazardous materials and obtaining permits for such transportation.	Relevant and Appropriate if hazardous material is transported offsite.
Air Quality Control	GA Chapter 391-3-1	Establishes policies, requirements, and standards to implement the Georgia Hazardous Waste management Act (O.C.G.A. Section 12-9-1). States that no person shall construct or operate any facility from which air contaminants are or may be emitted in such a manner as to fail to comply with any applicable standards of performance or any other requirement for a hazardous air pollutant established by EPA. Establishes a system for classifying air pollution sources and assures compliance with emission control standards. Sets forth ambient air quality standards which establishes certain maximum limits on parameters of air quality considered desirable for the preservation and enhancement of the quality of the State's air resources.	Relevant and Appropriate for handling of contaminated soil and treatment at the site; and if groundwater is treated via air stripping.

Notes:

CFR Code of Federal Regulations
NPDES National Pollutant Discharge Elimination System
OCGA Official Code of Georgia
USC United States Code

contamination that can be linked to past main facility activities based on contaminant levels, dispersion patterns, and potential transport pathways; therefore, the remediation of surface soils in OU-4 will focus on arsenic remediation. Considering the RGOs developed in the human health risk assessment, and potential future use of the site, an RG of 20 mg/kg in surface soil is identified.

As indicated in Section 2.2.4.2, homes with attic dust arsenic concentrations greater than 1,000 mg/kg would exceed the typical CERCLA action levels (ILCR >10^{-4} and noncarcinogenic HI >3) if exposure frequency was greater than once per month (USACE 2002).

2.8 Estimated Volume of Contaminated Media

2.8.1 Surface Soil

Generally, the extent of contamination for surface soil can be estimated by developing contour lines corresponding to the RG for each COC. The COCs then can be grouped by category and a composite contour for each group developed by overlaying the individual contaminant contours. A composite contour for the combined groups can be developed and the area inside that contour was calculated to determine the total area of contamination. Finally, volumes can be determined by multiplying the horizontal extent of contaminated soil by a vertical extent of 1 foot using the health based RGs for the site. Figure 2-3 illustrates the parcels where arsenic in surface soil was at levels above 20 mg/kg. Sixty parcels contained surface soil arsenic levels above 20 mg/kg. The volume of soil associated with the parcels depicted on Figure 2-3 was calculated as approximately 75,000 cubic yards (cy). This volume assumes the entire lateral surface within the boundary of a parcel is above the proposed RG. It does not consider structures or paved areas on the parcel, or the fact that some of the soils may not contain arsenic above the RG. To account for these situations, an assumption that approximately 75 percent of the total potential lateral area within the affected parcels contain soil above 20 mg/kg can be applied. Based on this assumption, the volume of contaminated soil is calculated as approximately 57,000 cy; however, several parcels contain arsenic at levels of 30 mg/kg or higher. Parcels with soil arsenic levels greater than 30 mg/kg (which constitutes approximately 15,000 of the 57,000 cy estimated above) would undergo a removal action prior to implementation of the ROD; therefore, the remedial alternatives developed for this FS focus on the remaining 42,000 cy of contaminated soil.

As previously indicated, the presence of organic COCs and remaining inorganic COCs were not used to develop soil volumes for remedial alternative development

U . S . EPA REGION IV

SDMS

Unscannable Material Target Sheet

DocID: 10513467 Site ID: GAD003269578

Site Name: Woolfolk

Nature of Material:

Map:		Computer Disks:	
Photos:		CD-ROM:	
Blueprints:		Oversized Report:	
Slides:		Log Book:	

Other (describe): Volume Calculation for Parcels

Amount of material:

Please contact the appropriate Records Center to view the material.

and comparison. The organic COCs were not considered because they were not used in any of the site operations and the soil concentrations and area of occurrences for the organic COCs and other inorganic COCs do not suggest that the WCW facility is the source of the organic COCs.

2.8.2 Attic Dust

Homes with attic dust arsenic levels greater than 1,000 mg/kg would undergo a time-critical removal action and, therefore, are not considered in this FS. However, approximately 19 homes have arsenic attic dust concentrations ranging from 500 to 1,000 mg/kg and another 41 homes have arsenic attic dust concentrations ranging from 71 mg/kg (background) to 500 mg/kg.

2.9 Remedial Action Objectives

CERCLA and the NCP define RAOs that are applicable to all Superfund sites. They relate to the statutory requirements for the development of remedial actions. Site-specific RAOs relate to potential exposure routes and specific contaminated media, such as soil, and are used to identify target areas of remediation and contaminant concentrations. They require an understanding of the contaminants in their respective media and are based upon the evaluation of risk to human health and the environment, protection of groundwater, information gathered during the RI, applicable guidance documents, and federal and state ARARs. RAOs are as specific as possible without unduly limiting the range of alternatives that can be developed for detailed evaluation.

In consideration of the COCs and RGs, the recommended RAOs for the WCW OU-4 Site are as follows:

Soil

- prevent ingestion, inhalation, or direct contact with surface soil that contain concentrations in excess of the RGs;
- prevent ingestion or inhalation of soil particulates in air that contain concentrations in soil in excess of the RGs;
- permanently and/or significantly reduce the mobility/toxicity/volume (M/T/V) of characteristic hazardous waste with treatment; and
- control future releases of contaminants to ensure protection of human health and the environment.

Attic Dust

- prevent ingestion, inhalation, or direct contact with attic dust that contain concentrations above background concentrations.

Section 3
Identification, Screening, and Evaluation of Technologies and Process Options

This section presents the identification and screening of technology types and process options applicable for remediation of contaminated media at the WCW OU-4 Site using the available site information and appropriate EPA guidance. The areas to be addressed through contaminated surface soil remediation were considered though the development of applicable technologies. Potential technologies and process options for contaminated media were identified and screened to eliminate infeasible or impractical options.

The GRAs for remediation include various containment, removal, treatment (in situ, ex situ, and off-site), and disposal options. Technologies within these categories have been considered for the site-related COCs in contaminated media at the WCW OU-4 Site. A preliminary screening of technologies was conducted on the basis of technical implementability, a consideration of principal threat versus low level threat waste (EPA 1991), and a consideration of applicable presumptive remedy guidance [metals in soil (EPA 1999), CERCLA municipal landfill sites (EPA 1993)]. The preliminary screening reduced the universe of potentially applicable technologies. Those technologies that can be technically implemented were further evaluated on the basis of effectiveness, implementability, and cost. Those technologies retained for remediation at the site were combined to form remedial action alternatives, presented in Section 4 and analyzed in detail in Section 5.

3.1 General Response Actions

Based on the established RAOs, site conditions, waste characteristics, volume of contaminated media requiring remediation, the existence of guidance identifying the presumptive remedy for groundwater, selection of technology alternatives for the remediation of soils contaminated with GRAs were identified. GRAs are those actions that singly or in combination, satisfy the RAOs for the identified media by reducing the concentration of hazardous substances or reducing the likelihood of contact with hazardous substances. The GRAs appropriate for addressing contamination at the WCW OU-4 Site include:

- no action,
- institutional controls,
- containment,
- removal/extraction,
- treatment, and
- disposal/discharge.

Each GRA was further investigated and screened for specific technologies and process options.

No Action. The no action response is identified for the purposes of establishing a baseline against which other GRAs are compared. There would not be any preventive or remedial action implemented as a result of the no action response, and the current contamination at the site would continue unabated. However, in accordance with CERCLA Section 121(c), a review/ reassessment of the conditions at the site is required at 5-year intervals to determine if other remedial action efforts are warranted.

Institutional Controls. Institutional controls are limited actions implemented to reduce the potential for human exposure to contaminants. Institutional controls may be physical, such as fences, barriers, or warning signs; or legal, including relocation, zoning, security-restricted access, deed restrictions or notices upon resale or transfer of title, and notices given to current or prospective owners or renters. Extended monitoring is also considered an institutional control. Like the no-action response, these actions would not reduce contaminant concentrations or protect environmental receptors. The contamination at the site would continue unabated.

Institutional actions may be appropriate at sites where there is a high rate of natural attenuation of biodegradable contaminants, the contaminants are immobile, the future use risk assessment scenario does not identify them as a potential future hazard, or when the benefits of cleanup are far outweighed by the cost to implement a remedial action. Institutional controls may be an appropriate response when used in conjunction with other remedial measures.

Containment. Containment consists of the construction of physical barriers to prevent human contact with contaminated material and to limit adverse effects on the environment. Common containment options include capping of contaminated areas and construction of slurry walls. Containment is used to isolate the contaminated media and to restrict migration of the contaminants via soil, water, or air pathways. It does not reduce the concentration or volume of contaminants. Containment is the presumptive remedy for low-level threat metals-in-soil wastes.

Removal/Extraction. Removal involves the physical removal of contaminated media from a site. As a result of such a removal, the area is no longer contaminated (as confirmed by testing of soil and/or groundwater) and may be restored to use. Removal generally refers to the excavation of solid media, such as soil or solid/bulk waste. It is usually used in conjunction with other technologies, such as treatment or disposal options, to achieve the RAOs for the removed media.

The removal response action does not reduce the concentrations of contaminants in the affected media. It merely transfers the contaminants to be addressed by another response action.

Treatment. Treatment involves the destruction of contaminants in the affected media, transfer of contaminants from one media to another, or alteration of the contaminants thus making them innocuous. The result is a reduction in M/T/V of the waste. Treatment technologies vary between environmental media and can consist of chemical, physical, thermal, and biological processes. Treatment can occur in place or above ground. This GRA is usually preferred unless site- or contaminant-specific characteristics make it infeasible from an engineering or implementation sense, or too costly. EPA expects to use treatment to address the principal threats posed by a site, wherever practicable.

Disposal/Discharge. Disposal involves the transfer of contaminated media, concentrated contaminants, or other related materials to a site reserved for treatment or long-term storage of such materials. This generally takes place on-site in a engineered landfill or off-site in an approved commercial or municipal landfill. Disposal does not reduce the concentration or volume of waste; it relocates it to a secure area.

Discharge also involves the transfer of contaminated media. It generally refers to the management of liquids. This response action involves discharging site liquids to an off-site location, such as a wastewater treatment plant, for disposal or further treatment. It also may involve on-site discharge via surface water, injection wells, or infiltration galleries.

3.2 Preliminary Screening of Technologies and Process Options

For each GRA there are various remediation methods, or technologies, used to carry out the response action. The term technology refers to general categories of technology types, such as thermal treatment. Each technology may have several process options, which refer to the specific material, equipment, or method used to implement a technology. For example, under the technology category of thermal treatment for soil, there may be incineration or thermal desorption process options. These technologies describe broad categories used in remedial action alternatives but do not address details, such as performance data, associated with specific process options.

In the initial phase of technology screening, process options and entire technology types were eliminated from consideration if they were difficult to implement due to their compatibility with site characteristics (e.g., physical features of the site and chemical characteristics of the medium of concern); or if the technology had not been proven to effectively control the COCs. These screening criteria were applied based on published information, experience with the technologies and process options, knowledge of site characteristics, and engineering judgment. Specifically, a technology or process option was rejected during the initial screening because it:

- would not be a practical method for the volume or area of contaminated media that is to be remediated;
- would not be an effective method for cleanup of all the contaminants, either as a sole technology or in combination with another technology, because of characteristics or concentrations of contaminants present at the site;
- would not be feasible or effective because of site conditions, including conditions such as location and size, surrounding land use, climate, geology and soils, hydrogeology, and characteristics of the contaminated media;
- could not be effectively administered;
- has not been successfully demonstrated for the site contaminants or media; or
- has extremely high costs relative to other equally effective technologies.

Table 3-1 describes the process options, present initial screening comments, and summarize the technology screening process for contaminated surface soil. A description of each process option is included in the table to provide an understanding of each option and to assist in the evaluation of its technical implementability. The screening comments address the technical feasibility and ability of a given process option to serve its intended purpose. The screening comments include a statement as to whether each process option was retained or rejected. The technologies and process options listed in the table were selected based on the fate and transport characteristics of the COCs identified in affected media and on the applicability of a given technology or process option to the soil. The retained technologies and process options are further evaluated in Section 3.3.

3.3 Evaluation of Retained Technologies and Process Options

Incorporation of all process options that survive initial screening into detailed alternatives would result in a cumbersome number of remedial action alternatives. To reduce that number, process options that survived initial screening were

Table 3-1 (Page 1 of 2)
Initial Screening of Technologies and Process Options for Contaminated Soil and Solid Media
Woolfolk OU4 Site
Fort Valley, Georgia

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
No Action	None	Not Applicable	Site is left in its existing state.	Required for consideration by the NCP.
Institutional Controls	Access and Use Restrictions	Land Use Restrictions	Land use restrictions recorded in property deeds to prohibit activities that might disturb contaminated soil.	Retained for further evaluation.
		Deed/Zoning Restrictions	Deeds for property in the area of contamination would include restrictions on wells and activities that might disturb contaminated soil.	Retained for further evaluation.
		Fencing	Security fence installed around contaminated area to limit access.	Retained for further evaluation.
	Environmental Monitoring	Air, Soil, and/or Groundwater	Site conditions and contaminant levels in these media would be monitored during and after implementation of remedial action.	Retained for further evaluation.
Containment	Caps	All Processes	Placement of a cap of low permeability material over the area occupied by the contaminated soil to minimize the infiltration of surface water. Cap types include native soil, clay, asphalt, concrete, synthetic membrane, and RCRA multilayer.	Rejected. Operable Unit 4 is defined as offsite surface soils which occur over a large number of inhabited residential and commmercial properties that would be difficult to cap efficiently.
	Subsurface Barriers	All Processes	Use of grouts, low permeability slurry, or liners placed beneath wastes to limit leaching of contaminants (horizontal barrier) or perpendicular to wastes to form an impermeable barrier (vertical barrier).	Rejected. Operable Unit 4 is defined as offsite surface soils.
Removal	Excavation	All Processes	Use of mechanical excavating equipment to remove and load contaminated soil for transport.	Retained for further evaluation.
	Decontamination	All Processes	Use of equipment/procedures to remove contaminated dust from attics.	Retained for further evaluation.
Treatment	In Situ	Biodegradation	The activity of naturally-occurring microbes is stimulated by circulating water-based solutions through contaminated soil to enhance in situ biological degradation of organic contaminants. Nutrients, oxygen, or other amendments may be used to enhance biodegradation and contaminant desorption from subsurface materials.	Rejected. Not effective for metals.
		Bioventing	Oxygen is delivered to contaminated unsaturated soil by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation. The system also may include the injection of contaminated gases, using the soil system for remediation.	Rejected. Not effective for metals.
		Phytoremediation	Contaminants are made unavailable to biological organisms after uptake through tree (e.g. poplar) roots.	Retained for further evaluation.
		Soil Flushing	Water, or water containing an additive to enhance contaminant solubility, is applied to the soil or injected into the groundwater to raise the water table into the contaminated soil zone. Contaminants are leached into the groundwater, which is then extracted and captured/treated/ removed.	Rejected. Area of concern is limited ot surface soils.
		Soil Vapor Extraction	Vacuum is applied through extraction wells to create a pressure gradient that induces gas-phase volatiles to diffuse through soil to extraction wells. The process includes a system for handling offgases. This technology is known as in situ soil venting, in situ volatilization, enhanced volatilization, or soil vacuum extraction.	Rejected. Area of concern is limited to surface soils.
		Solidification/Stabilization/ Composting/Fixation	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Rejected. Technology would be difficult to implement since soils occur in occupied properties. Also, area of concern is limited to surface soils.
		Vitrification	Electrodes for applying electricity, or joule heating, are used to melt contaminated soil, producing a glass and crystalline structure with very low leaching characteristics.	Rejected. Technology would be difficult to implement since soils occur in occupied properties. Also, area of concern is limited to surface soils.
		Steam Extraction	Steam/hot air injection is used to increase the mobility of volatiles and facilitate extraction. The process includes a system for handling offgases.	Rejected. Not effective for metals.
	Offsite	RCRA Hazardous Waste Treatment Facility	Contaminated soils are excavated and transported to an offsite facility for treatment and disposal.	Retained for further evaluation.

Process option eliminated from further consideration

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
	Thermal	Incineration	High temperatures, 1,600 to 2,200 degrees F, are used to volatilize and combust (in the presence of oxygen) organic contaminants in hazardous waste. Processes include liquid injection, rotary-kiln, fluidized- and circulatory-bed, and infrared.	Rejected. Not applicable to metals contamination.
		Thermal Desorption	Wastes are heated at low or medium temperatures to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.	Rejected. Not applicable to metals contamination.
		Pyrometallurgical Processing	Pyrometallurgy encompasses elevated temperature techniques for extraction and processing of metals, including roasting, retorting and smelting for use or disposal. One class of pyrometallurgical processes uses a thermal means to cause volatile metals to separate from the soils and report to the flyash, which is then immobilized.	Retained for further evaluation.
		Vitrification	Contaminated soil is melted at high temperatures to form glass and crystalline characteristics.	Retained for further evaluation.
	Biological	Solid Phase	Excavated soil is mixed with soil amendments and placed in aboveground enclosures that have leachate collection systems and some form of aeration. Processes include prepared treatment beds, biotreatment cells, and soil piles. Moisture, heat, nutrients, oxygen, and pH may be controlled to enhance biodegradation.	Rejected. Not applicable to metals contamination.
		Slurry Phase	An aqueous slurry is created by combining soil with water and other additives. The slurry is mixed to keep solids suspended and microorganisms in contact with the soil contaminants. Nutrients, oxygen, and pH in the bioreactor may be controlled to enhance biodegradation. Upon completion of the process, the slurry is dewatered and the treated soil is disposed.	Rejected. Not applicable to metals contamination.
	Physical/Chemical	Soil Washing	Contaminants sorbed onto the soil particles are separated from soil in an aqueous-based system. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.	Retained for further evaluation for the treatment of site contaminants.
		Solidification/Stabilization/ Composting/Fixation	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions /interactions are induced to help remove organics and heavy metals or otherwise prevent solubilization of contaminants.	Retained for further evaluation for the treatment of site contaminants.
		Dehalogenation (Glycolate)	An alkaline polyethylene glycolate (APEG) reagent is used to dehalogenate halogenated aromatic compounds in a batch reactor. Potassium polyethylene glycolate (KPEG) is the most common APEG reagent. Contaminated soil and the reagent are mixed and heated in a treatment vessel. In the APEG process, the reaction causes the polyethylene glycol to replace halogen molecules and render the compound nonhazardous. The reaction between chlorinated organics and KPEG causes replacement of a chlorine molecule and results in a reduction in toxicity.	Rejected. Not applicable to metals contamination.
		Chemical Extraction	Waste contaminated soil and extractant are mixed in an extractor, dissolving the contaminants. The extracted solution is then placed in a separator, where the contaminants and extractant are separated for treatment and further use.	Retained for further evaluation.
		Chemical Reduction/Oxidation	Reduction/oxidation chemically converts hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The reducing/oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, and chlorine. Chemical oxidation is often enhanced using ultraviolet (UV) irradiation or chemical catalysts.	Retained for further evaluation for the treatment of site contaminants.
		Gas-Phase Chemical Reduction	The patented ELI Eco Logic International, Inc. uses a gas-phase reduction reaction of hydrogen with organic and chlorinated organic contaminants at elevated temperatures to convert contaminants into a hydrocarbon-rich gas product. Soil is handled within a thermal desorption unit which is operated in conjunction with the reduction reactor.	Rejected. Not applicable to metals contamination.
Disposal	Onsite	Onsite RCRA Landfill	Excavated soil is permanently disposed of in a centrally-located RCRA landfill.	Rejected. OU4 consists of offsite surface soils occuring in occupied residential and commercial properties.
		Backfill Treated Material	Treated soil is placed in a central location (e.g., OU3) or back into excavated areas.	Retained for further evaluation.
	Offsite	RCRA Landfill (Hazardous or Nonhazardous)	Excavated soil (treated or untreated) is disposed of in a RCRA Subtitle C or D landfill depending on TCLP results.	Retained for further evaluation.

Process option eliminated from further consideration

reevaluated on the basis of effectiveness, implementability, and cost. In cases where several process options had similar evaluations, a single process option considered representative of each technology type was selected. Identifying a representative process option for each technology type was not intended to limit the process options that could be employed in the remedial design, but instead, provide a basis for evaluation of a manageable number of alternatives. In some cases, more than one process option may have been selected for a technology type because the options were sufficiently different in performance to preclude selecting one as representative of all. The choice of specific process options for a selected technology can and should be evaluated more completely during the remedial design phase.

Effectiveness. Specific technology processes were evaluated for their effectiveness in protecting human health and the environment and in satisfying one or more of the RAOs defined for each category of media. This evaluation compared the effectiveness of the process options within the same technology types, while maintaining a variety of technologies needed to develop a range of alternatives. This criterion focused on

- the degree to which a process option reduces M/T/V through treatment and minimizes residual risks,
- the effectiveness in handling the estimated areas or volume of media and meeting the RGOs identified,
- the effectiveness in protecting human health and the environment during the construction phase and operation and how quickly it achieves protection,
- the degree to which the process option complies with all requirements, and
- how proven and reliable the process option is with respect to the contaminants at the site.

Options providing significantly less effectiveness than other, more promising options were eliminated.

Implementability. This criterion focused on the technical feasibility and availability of the option and the administrative feasibility of implementing the option. During the first screening, process options that were ineffective or unworkable at the site were eliminated as being technically feasible. The secondary screening continued the evaluation on a more detailed level, placing greater emphasis on the institutional aspects. Implementability considered

- availability of treatment, storage, and disposal services as well as capacity; and
- availability of necessary equipment and skilled workers to implement the technology.

Options that were technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time were eliminated from further consideration.

Cost. The costs of construction and any long-term costs associated with operation and maintenance (O&M) were considered. Costs that were excessive compared to the overall effectiveness of options was considered as one of several factors used to eliminate options. Options providing effectiveness and implementability similar to those of another option by employing a similar method of treatment or engineering control, but at a greater cost, were eliminated. It should be noted that the greatest cost variability during site remediation is generally seen between the technology types, rather than within specific process options in a given technology.

Relative costs are used rather than detailed estimates. At this stage in the process, the cost analyses are subjectively made on the basis of engineering judgment. Each process option was evaluated as to whether costs are high, moderate, or low relative to other process options of the same technology groups. In terms of dollars, cost ranges with respect to total cost consisted of:

- high = >$5 million,
- moderate = $1 to $5 million, and
- low = <$1 million.

The evaluation of the retained technologies and process options based on effectiveness, implementability, and cost is presented in Table 3-2. A summary of the retained technologies and process options is presented in Table 3-3. These technologies and process options were used in the development of the remedial action alternatives as presented in Section 4. Several technologies and process options were eliminated from further analysis. Access and use restrictions were eliminated from further consideration because it would be difficult to restrict access by inhabitants of private properties to contaminated surface soil on those properties. Capping soils in place was not considered further because the contaminated surface soils occur in individual properties that together, cover a large area. Several in situ treatment technologies were eliminated from further consideration because of the time needed to complete remediation, the restrictions on currently inhabited properties that would need to be employed, or the inefficiency of an in situ treatment of contamination that is limited to surface soils.

Table 3-2
Evaluation of Process Options for Contaminated Soils and Solid Media
Woolfolk OU4 Site
Fort Valley, Georgia

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost
No Action	None	Not Applicable	Does not achieve any measure of remediation or meet RAOs.	Readily implementable since no action is taken.	Negligible
Institutional Controls	Access and Use Restrictions	Land Use Restrictions	Does not achieve any measure of remediation or meet RAOs. Effectiveness depends on enforcement of restrictions. Used in conjunction with other technologies.	Would be difficult to implement and enforce restrictions since contaminated soils occur over a large number of inhabited residential properties.	Minimal
		Deed/Zoning Restrictions	Does not achieve any measure of remediation or meet RAOs. Effectiveness depends on enforcement of restrictions. Used in conjunction with other technologies.	Readily implementable.	Minimal
		Fencing	Does not achieve any measures of remediation or meet RAOs. Does not provide protection to inhabitants of contaminated properties.	Readily implementable. Requires long-term maintenance. Equipment, services, and personnel readily available.	Low capital; low O&M
	Environmental Monitoring	Air, Soil, and/or Groundwater	Does not achieve any measure of remediation or meet RAOs. Useful for tracking contaminant migration and/or effectiveness of remedial actions. Used in conjunction with other technologies.	Readily implementable. No construction or operation is necessary. Equipment, services, and personnel are already available and procedures are in place.	Low capital; negligible O&M
Removal	Excavation	All Processes	Proven, reliable technology. Would effectively reduce the potential threat to human health. Short-term effects include noise and fugitive dust emissions. Would be used in conjunction with an ex situ treatment technology.	Easily implementable. Equipment, personnel, and services readily available.	Moderate capital; negligible O&M
	Decontamination	All Processes	Proven, reliable technology. Would effectively reduce the potential threat to human health. Short-term effects	Easily implementable. Equipment, personnel, and services readily available.	Moderate capital; negligible O&M
Treatment	In Situ	Phytoremediation	Generally limited to soils within three feet of the surface and groundwater within 10 feet of the surface. Long length time required for remediation. Efficiencies are often too low to meet sensitive endpoints. Contaminants may still enter the food chain through animal/insects that eat plant material containing contaminants.	Readily implementable. Ex situ treatment via wetlands troughs may be necessary for deeper contamination. Requires a large surface area of land. Modification of ground surface at the site may be necessary to prevent flooding or erosion.	Low to moderate capital; low O&M
	Offsite	RCRA Hazardous Waste Treatment Facility	Effectively reduces the potential threat to human health. Feasibility depends on the amount of soil that would need to be excavated, transported, treated, and disposed offsite.	Readily implementable. Equipment, services, and personnel readily available.	Moderate to high capital; low O&M
	Thermal	Pyrometallurgical Processing	Pyrometallurgical processing usually is preceded by physical treatment to produce a uniform feed material and upgrade the metal content. In order for this technology to be technically feasible, it must be possible to generate a concentrate from the contaminated soil that will be acceptable to the processor.	Few pyrometallurgical systems are currently available in mobile or transportable configurations. Offsite treatment must comply with EPA's offsite treatment policies and procedures. Unless a very concentrated feed stream can be generated, there will be a charge in addition to transportation, for processing the concentrate.	High capital; high O&M
		Vitrification	Contaminants suitable for this technology my be organic or inorganic. Offgas treatment system required. Treated soil requires 1-2 years to cool.	Ex situ vitrification faces implementation problems where waste contains >25% moisture content (causing excessive fuel consumption), metals concentration in soils exceed their solubility in glass, or As is present in waste (may require pretreatment to produce less volatile forms).	High to very high capital; high O&M
	Physical/Chemical	Soil Washing	Will result in a concentration of contaminants. Could be used with other technologies as a volume reduction step.	Residuals would have to be further treated and disposed.	High capital; moderate O&M
		Solidification/Stabilization/ Composting/Fixation	Composting not effective for inorganics; solidifciation/stabilization would be required for them. Composting may only partially decompose some contaminants and in some cases leave decomposition products that are more toxic than the original contaminant.	Requires relatively simple technologies; easy to construct and operate. May result in a significant increase in volume.	Moderate to high capital; moderate O&M
		Chemical Extraction	Effective and reliable method for contaminants. Traces of chemical may remain in the treated solids, thus the toxicity of the chemical is an important consideration. This process would not destroy the waste, but would separate the contaminants and reduce the volume of waste to be treated.	Control of emissions may be required. Some chemicals may be toxic to some organisms; requiring very efficient separation of the chemical from the solids before disposal. Contaminated chemical solution would have to be dealt with.	High capital; high O&M
		Chemical Reduction/Oxidation	Extensive treatability testing would be required to evaluate the overall effectiveness of the process. Incomplete oxidation or formation of intermediate contaminants may occur depending on the contaminants and oxidizing agents used.	Solids must be in solution. Waste composition must be well-known to prevent the inadvertent production of a more toxic or hazarodus end product.	Moderate capital; moderate O&M
Disposal	Onsite	Backfill Treated Material	Effective means for placement of treated material back onsite. Note that land disposal restrictions must be met prior to placement.	Readily implementable.	Low capital; negligible O&M
	Offsite	RCRA Landfill (Hazardous or Nonhazardous)	Excavation and removal of contaminated soil to a RCRA landfill have been performed in the past but probably will be more difficult to carry out with the consideration of landban restrictions.	Readily implementable. However, this technology requires knowledge of LDRs and other regulations developed by state government regarding RCRA hazardous wastes.	Moderate to high capital; negligible O&M

Process option eliminated from further consideration

Table 3-3
Summary of Retained Technologies and Process Options
for Contaminated Surface Soil and Solid Media
Woolfolk Chemical Works Site, OU-4, Fort Valley, Georgia

General Response Action	Remedial Technology	Process Option
No Action	None	Not Applicable
Institutional Controls	Environmental Monitoring	Air, Soil, and/or Groundwater
Removal	Excavation	All processes
	Decontamination	All processes
Treatment	Off-site	All processes
	Physical/Chemical	Soil Washing Solidification/Stabilization/Composting/Fixation Chemical Extraction
Disposal	On-site	Backfill Treated Material
	Off-site	Subtitle C or D Landfill

Thermal treatment technologies were eliminated from further consideration because of the anticipated high cost relative to other treatment technologies. Phytoremediation was eliminated from further consideration because of treatment duration. Several other treatment technologies were eliminated from further consideration because they would not effectively treat arsenic.

Finally, creation of an on-site RCRA landfill was eliminated from further consideration because of space requirements, the need for compliance with state landfill siting requirement, as well as permanent restrictions on future land use and long-term maintenance.

Section 4
Development and Screening of Alternatives

The objective of this section is to combine the list of previously screened technologies and process options to form a range of remedial action alternatives for the WCW OU-4 Site. To address the site-specific RAOs, a variety of alternatives were formulated by combining the retained technologies in Section 3.3. The range of alternatives for surface soil includes no action, institutional controls, removal, treatment, and disposal options.

In formulating alternatives, contaminants with concentrations above RGs, applicable technologies, and the contaminants which these technologies most effectively address were considered. The goal in developing remedial action alternatives is to provide a range of cleanup options together with sufficient information to adequately compare alternatives against each other.

Each alternative developed and described in this section was evaluated to determine its overall effectiveness, implementability, and cost. These criteria for alternative evaluation are similar to that previously used to evaluate the process options. The use of effectiveness, implementability, and cost as evaluation criteria has been defined in Section 3.3.

After each criterion was evaluated, remedial alternatives with the most favorable overall evaluations were retained to undergo detailed analysis. The screening procedure attempts to maintain representative alternatives from a full range of technologies. Those alternatives not selected may be considered at a later step during the design stage if information is developed that identifies an additional advantage not previously apparent or an alternative for a similar retained alternative that continues to be evaluated favorably. A summary of the developed alternatives for the WCW OU-4 Site is presented in Table 4-1.

4.1 Soil Alternatives Analysis

The alternatives that were developed for surface soil at the WCW OU-4 Site include: (1) no action, (2) excavation with soil washing, (3) excavation with solidification/stabilization/composting/fixation, (4) excavation with chemical extraction, (5) excavation with treatment and off-site disposal, and (6) excavation and disposal at Subtitle C landfill.

Table 4-1
Development of Remedial Action Alternatives for Soil
Woolfolk Chemical Works Site, OU-4, Fort Valley, Georgia

Alternative	Description of Alternative
1	No Action
2	Excavation, Transportation to Main Facility for Treatment with Soil Washing Excavate contaminated surface soil Consolidate material onto main facility and treat by soil washing Coordinate disposal of treated material in OU-3 with OU-3 remediation Backfill excavated areas with clean fill/topsoil Revegetate excavated areas Decontaminate attics in homes w/attic dust arsenic concentrations of 500–1000 mg/kg Conduct limited decontamination of attics in homes with attic dust arsenic concentrations of 71 to 500 mg/kg Decontaminate drainage ditch pipe from facility to Spillers Street Media monitoring
3	Excavation, Transportation to Main Facility for Treatment with Solidification/ Stabilization/Composting/Fixation Excavate contaminated surface soil Consolidate material onto main facility and treat by solidification/stabilization Coordinate disposal of treated material in OU-3 with OU-3 remediation Backfill excavated areas with clean fill/topsoil Revegetate excavated areas Decontaminate attics in homes w/attic dust arsenic concentrations of 500–1000 mg/kg Conduct limited decontamination of attics in homes with attic dust arsenic concentrations of 71 to 500 mg/kg Decontaminate drainage ditch pipe from facility to Spillers Street Media monitoring
4	Excavation, Transportation to Main Facility for Treatment with Chemical Extraction Excavate contaminated surface soil Consolidate material onto main facility and treat by chemical extraction Coordinate disposal of treated material in OU-3 with OU-3 remediation Backfill excavated areas with clean fill/topsoil Revegetate excavated areas Decontaminate attics in homes with attic dust arsenic concentrations of 500–1000 mg/kg Conduct limited decontamination of attics in homes with attic dust arsenic concentrations of 71 to 500 mg/kg Decontaminate drainage ditch pipe from facility to Spillers Street Media monitoring

Table 4-1 (continued)
Development Of Remedial Action Alternatives For Soil
Woolfolk Chemical Works Site, OU-4, Fort Valley, Georgia

Alternative	Description of Alternative
5	Excavation, Transportation for Off-Site Treatment and Disposal at Subtitle D Landfill Excavate contaminated surface soil Transport soil off-site for treatment and disposal Backfill excavated areas with clean fill/topsoil Revegetate excavated areas Decontaminate attics in homes w/attic dust arsenic concentrations of 500–1000 mg/kg Conduct limited decontamination of attics in homes w/attic dust arsenic concentrations of 71 to 500 mg/kg Decontaminate drainage ditch pipe from facility to Spillers Street Media monitoring
6	Excavation, Off-site Transportation and Disposal at Subtitle C landfill Excavate contaminated surface soil Transport soil off-site for disposal at secure RCRA landfill Backfill excavated areas with clean fill/topsoil Revegetate excavated areas Decontaminate attics in homes w/attic dust arsenic concentrations of 500–1000 mg/kg Conduct limited decontamination of attics in homes w/attic dust arsenic concentrations of 71 to 500 mg/kg Decontaminate drainage ditch pipe from facility to Spillers Street Media Monitoring

4.1.1 Alternative 1 - No Action

4.1.1.1 Description

Under this alternative, no action would be taken to remedy the contaminated surface soil or other solid media at the site. The alternative would only involve the continued monitoring of soil, sediment, and surface water quality at the site. Approximately 100 surface soil samples would be collected from the affected areas and analyzed for the COCs every five years for 30 years. Public health evaluations would be conducted every five years and would allow EPA to assess the ongoing risks to human health and the environment posed by the WCW OU-4 Site. The evaluations would be based on the data collected from media monitoring.

4.1.1.2 Effectiveness

The no action alternative is required by the NCP to be carried through the screening process, as it serves as a baseline for comparison of the site remedial action alternatives. This alternative does not reduce the exposure of receptors to site contaminants. Continued migration of contaminants and the resulting exposure of receptors would occur. As a result, this alternative is not effective in protecting human health or the environment, or reducing M/T/V of contaminants at the site. Monitoring proposed under this alternative would allow EPA to assess the ongoing threats to human health and the environment posed by the site.

4.1.1.3 Implementability

The only task which would require implementation under this alternative is the periodic media monitoring at the site. This alternative could be easily implemented since monitoring equipment is readily available and procedures are in place.

4.1.1.4 Cost

Minimal costs are associated with this alternative relative to other remedial action alternatives. No capital costs are associated with this alternative. Annual O&M costs for media sampling associated with monitoring exists.

4.1.2 Alternative 2—Excavation, Transportation to Main Facility for Treatment With Soil Washing

4.1.2.1 Description

This alternative involves excavating contaminated surface soil and transporting it to a central area in the main facility for consolidation and staging. Soil washing treatment would be performed and the treated material would be incorporated into OU-3 backfill. Alternately, treated material could be disposed off-site in a RCRA Subtitle D landfill depending on OU-3 Site earthwork balance. Excavated areas would be backfilled with clean top soil. The final soil washing treatment system would depend upon the outcome of treatability testing and would be determined during the remedial design phase. Note that the use of OU-3 for disposal of treated material would mean that OU-3 and OU-4 remediation would occur at the same time, or OU-4 would occur before OU-3 and the soil temporarily stockpiled (and covered) awaiting OU-3 activities.

The soil volumes of the areas to be excavated are presented in Section 2.8. Contaminated areas are illustrated in Figure 2-3.

Soil washing generally involves four treatment steps including size separation, mixing, washing, and rinsing. Washing solution(s) are introduced to the waste during the washing step of the treatment process. Once the contaminated material is exposed to the washing solution for an appropriate length of time, the liquid and solid phases are separated. Fine particles are generally separated in a sedimentation tank with, or without, the addition of flocculating agents. Some silty clay particles must be removed using more aggressive separation methods such as centrifuges or hydrocyclones.

The liquid phase containing the leached contaminants is then concentrated or treated in some manner to reduce the volume and toxicity of the liquid waste. Clarification and precipitation are commonly used methods for separating contaminants from the liquid phase. Soil washing is most cost efficient when contaminants can be removed from the liquid phase and the washing solution reused in the treatment process.

Chemical addition to wash water can often increase the efficiency of the treatment process. Surfactants are utilized to increase the solubility of hydrophobic organic compounds during mixing, washing, and rinsing steps of the soil washing treatment process. Acids are often used to solubilize metals, whereas bases, such as sodium hydroxide are used to precipitate contaminants such as metals from the washing or flushing solution. Chelating agents such as ethylene diamine tetraacetic acid also are commonly used to remove inorganic contaminants.

Soil washing is often used in conjunction with other technologies to treat waste. Often, washed soil must be dewatered to remove liquid and increase the solids content. Spent washing solution is normally treated using wastewater treatment methods. Sludges that are generated during the wash water treatment process must be treated using technologies such as incineration, immobilization, or biodegradation.

Before full-scale implementation of soil washing could occur, additional treatability testing would be required to support the past studies and further refine process parameters. This study also would be required to confirm that this alternative would be able to meet the RAOs for the site. Site access would be restricted by the existing fence around the site (with upgrades, as necessary). Deed restrictions may be placed on the OU-3 Site while the remedial action takes place. Water would be used to minimize fugitive dust emissions during soil excavation, transport, and handling. Any stockpiles of material during interim storage would be covered by tarps or plastic sheeting to minimize fugitive dust and runon/runoff emissions. Surface water runoff, fugitive emissions and treated soils would be monitored to ensure that the RAOs were being met, as well as to assess the effectiveness of the remedial action.

In addition to soil remediation activities, this alternative also addresses homes with arsenic contamination in attic dust. Homes where attic dust arsenic concentrations are greater than 1,000 mg/kg will undergo a time critical removal action and, therefore, are not addressed as part of this alternative. However, homes with arsenic attic dust concentrations ranging from 500 to 1,000 mg/kg will undergo a decontamination of the attic to reduce dust and arsenic concentrations. The following steps are anticipated:

- Preparation of the attic in a manner similar to an asbestos removal action to minimize dispersion of dust.
- Removal of all insulation and other items from the attic. Insulation will be disposed and all resident personal property will be high-efficiency particulate air (HEPA) vacuumed and damp wiped (if possible) and returned to resident.
- Attic will be HEPA vacuumed and damp wiped when possible.
- Use of a lock down agent to encapsulate any remaining dust.
- Replacement of removed insulation with new insulation.
- Confirmation sampling.

Approximately 19 homes will undergo the decontamination procedure listed above. An additional 41 homes where arsenic attic dust concentrations range from 71 mg/kg (background) to 500 mg/kg will undergo the following procedures:

- Preparation of the attic in a manner similar to an asbestos removal action to minimize dispersion of dust.
- Removal of all personal property from the attic. Items will be will be HEPA vacuumed and damp wiped (if possible), bagged (when possible) and returned to resident.
- Attic surfaces will be HEPA vacuumed and damp wiped when possible.
- Preparation of advisory notices containing information on the safe use of their attic space for residents.
- Confirmation sampling.

Note, that if warranted, the steps in the attic dust decontamination process may be changed to improve the efficiency of the overall process based on the outcome of testing conducted during the cleanup.

A final component of this alternative is the decontamination of the portion of the drainage ditch which begins at the facility and leads to Spillers Street that is composed of pipe. The pipe will be flushed to remove any potentially contaminated sediment and soil that has accumulated so that it can be treated along with the excavated surface soils. Water used to decontaminate the pipe will need to be managed, treated if necessary and properly disposed.

4.1.2.2 Effectiveness

Removal of contaminated soil with on-site treatment virtually eliminates the risks associated with the exposure pathways. Soil washing eliminates the risks associated with organic and inorganic-contaminated material since it reduces the volume of contaminants in the media. Further treatment of the wash water and sludge would remove the contaminants from these media. This combination of technologies would ensure that the selected treatment system would remediate surface and subsurface soil contamination to concentrations meeting RGOs, and RAOs would be met. Removal and on-site treatment permanently eliminates the long-term health risks both on-site and off-site, as well as reduces the M/T/V.

4.1.2.3 Implementability

Implementation of this process option is considered technically feasible. The equipment and materials for this action are commercially available from several vendors. Additional treatability studies of the treatment technologies would need to be performed to refine design parameters. It also may be appropriate to evaluate other potential technologies for the treatment of wash water and sludge from the soil washing process. Considerations associated with the treatment system include the design, installation, and testing of the system and cleanup verification. Confirmatory sampling would be required to verify that the excavated areas meet the RGOs. Monitoring the operation of the treatment system operation would be required to verify that the treated material meets the goals.

4.1.2.4 Cost

Moderate costs are associated with this alternative relative to other remedial action alternatives. Typical expenditures would include capital costs for equipment and construction of the treatment system, as well as excavation and backfilling/final grading of the treated material. In addition, monitoring costs associated with excavation and treatment verification are realized costs. Annual O&M costs associated with this alternative include maintenance of the treatment system. The O&M costs are assumed to extend over a 1- to 2-year period.

4.1.3 Alternative 3 – Excavation, Transportation to Main Facility for Treatment with Solidification/Stabilization/Composting/ Fixation

4.1.3.1 Description

This alternative involves excavating contaminated surface soil and transporting it to a central area in the main facility for consolidation and staging. On-site treatment via solidification/stabilization/composting/fixation would be performed and the treated material would be incorporated into OU-3 backfill. Alternately, treated material could be disposed off-site in a RCRA Subtitle D landfill depending on the OU-3 Site earthwork balance. Excavated OU-4 areas would be backfilled with clean top soil. The final treatment system would depend upon the outcome of treatability testing and would be determined during the remedial design phase. Note that the use of OU-3 for disposal of treated material would mean that OU-3 and OU-4 remediation would occur at the same time, or OU-4 would occur before OU-3 and the soil temporarily stockpiled (and covered) awaiting OU-3 activities.

The soil volumes of the areas to be excavated are presented in Section 2.8. Contaminated areas are illustrated in Figure 2-2.

Contaminants within soil would be physically bound or enclosed within a stabilized mass (solidification), or chemical reactions would be induced between a stabilizing agent and the contaminant to reduce its mobility (stabilization). Solidification/ stabilization treatment technologies include the addition of cement, lime, pozzolan, or silicate-based additives or chemical reagents that physically or chemically react with the contaminant. These materials chemically react with water to form a solid cementious matrix which improves the handling and physical characteristics of the waste. They also raise the pH of water which may help precipitate and immobilize some heavy metal contaminants.

Another treatment option for this alternative is the use of a patented chemical treatment process. Sevenson's patented MAECTITE® chemical treatment process stimulates chemical bonding to nucleate substituted mixed mineral forms in the apatite and barite mineral groups that are stable and resistant to leaching in a variety of extraction fluids and pH ranges, although multiple-valence metallic cations such as arsenic may need redox manipulation through oxidizers/reducants. The end product of the MAECTITE® treatment is a nonhazardous material similar to soil, but with no volume increase and minimal increase in mass. Once treated and confirmed to be nonhazardous, the soil would be disposed in an on-site, unlined excavation.

Alternative 3 also includes the remediation of arsenic contaminated attic dust in selected residences and the decontamination of the drainage ditch pipe as described under Alternative 2.

4.1.3.2 Effectiveness

Under this alternative, contaminated media would be treated and converted to a nonhazardous, nonleachable material and buried on the OU-3 Site. Migration of hazardous contamination to groundwater would be eliminated because the treated, buried material would effectively bind or bond the contaminants, preventing leaching and contaminant migration. This combination of technologies would ensure that the selected treatment system would remediate surface soil and sediment contamination to concentrations meeting RGs, and RAOs would be met. Excavation and on-site treatment permanently eliminates the long-term health and environmental risks at the site, as well as reducing contaminant mobility.

4.1.3.3 Implementability

Equipment, services, and personnel should be readily available from many vendors.

4.1.3.4 Cost

Moderate to high costs are associated with this alternative relative to other remedial action alternatives. Typical expenditures would include capital costs for equipment and construction of the treatment system, as well as excavation. In addition, monitoring costs associated with excavation and treatment verification are realized costs.

4.1.4 Alternative 4—Excavation, Transportation to Main Facility for Treatment with Chemical Extraction

4.1.4.1 Description

This alternative involves excavating contaminated surface soil and transporting it to a central area in the main facility for consolidation and staging. On-site treatment via chemical extraction would be performed and the treated material would be incorporated into OU-3 backfill. Alternately, treated material could be disposed off-site in a RCRA Subtitle D landfill depending on OU-3 Site earthwork balance. Excavated OU-4 areas would be backfilled with clean top soil. The final treatment system would depend upon the outcome of treatability testing and would be determined during the remedial design phase. Note that the use of OU-3 for disposal of treated material would mean that OU-3 and OU-4 remediation would occur at the same time, or OU-4 would occur before OU-3 and the soil temporarily stockpiled (and covered) awaiting OU-3 activities.

The soil volumes of the areas to be excavated are presented in Section 2.8. Contaminated areas are illustrated in Figure 2-2.

With chemical extraction, waste-contaminated soil and extractant are mixed in an extractor, dissolving the contaminants. The extracted solution is then placed in a separator, where the contaminants and extractants are separated for treatment and further use. Chemical extraction does not destroy wastes, but by separating hazardous contaminants from soils, reduces the volume of hazardous waste that must be treated.

Physical separation steps are often used before chemical extraction to grade soil into coarse and fine fractions, with the assumption that the fines contain most of the contamination. Physical separation can also enhance the extraction by separating out particulate heavy metals.

Site access would be restricted by the existing fence around the site (with upgrades, as necessary). Deed restrictions may be placed on the site while the remedial action takes place. Water would be used to minimize fugitive dust emissions during soil excavation, transport, and handling. Any stockpiles of material during interim storage would be covered by tarps or plastic sheeting to minimize fugitive dust and runon/runoff emissions. Surface water runoff, fugitive emissions and treated soils would be monitored to ensure that the RAOs were being met, as well as to assess the effectiveness of the remedial action.

Alternative 4 also includes the remediation of arsenic contaminated attic dust in selected residences and the decontamination of the drainage ditch pipe as described under Alternative 2.

4.1.4.2 Effectiveness

Removal of contaminated soil with on-site treatment virtually eliminates the risks associated with the exposure pathways. Chemical extraction eliminates the risks associated with organic-contaminated material since it removes the contaminants from the media. This treatment system would remediate surface and subsurface soil contamination to concentrations meeting RGOs, and RAOs would be met. Removal and on-site treatment permanently eliminates the long-term health risks both on-site and off-site, as well as reduces the M/T/V.

4.1.4.3 Implementability

Implementation of this process option is considered technically feasible. The equipment and materials for this action is currently available through one vendor which has a patent on the process. Treatability studies of the technology would need to be performed. Considerations associated with the treatment system include the design, installation, and testing of the system; permitting requirements; and cleanup verification. Confirmatory sampling would be required to verify that the excavated areas meet the RGOs. Monitoring the treatment system operation would be required to verify that the treated material meets the goals.

4.1.4.4 Cost

Moderate to high costs are associated with this alternative relative to other remedial action alternatives. Typical expenditures would include capital costs for equipment and construction of the treatment system, as well as excavation and backfilling/final grading of the treated material. In addition, monitoring costs associated with excavation and treatment verification are realized costs. Annual O&M costs associated with this alternative include maintenance of the treatment system.

4.1.5 Alternative 5—Treatment and Offsite Disposal

4.1.5.1 Description

This alternative consists of transporting contaminated soils off-site to a treatment facility for treatment and disposal. Contaminated OU-4 surface soils would be excavated and transported from each residence/parcel to a central area on the main facility for consolidation, evaluation, treatment (if necessary) and staging. Alternately, off-site shipment of soil in trucks to an off-site treatment facility could be initiated. Treated soils would be disposed in an off-site Subtitle D disposal facility. Note that the use of OU-3 for staging of material would mean that OU-3 and OU-4 remediation would occur at the same time, or OU-4 would occur before OU-3 and the soil temporarily stockpiled (and covered) awaiting OU-3 activities. This alternative will remove from the site all contaminated soils.

Water would be used to minimize fugitive dust emissions during soil excavation, transport, and handling. Any stockpiles of material during interim storage would be covered by tarps or plastic sheeting to minimize fugitive dust and runon/runoff emissions. Surface water runoff, fugitive emissions and treated soils would be monitored to ensure that the RAOs were being met.

After removal of all applicable contaminated soils, the excavations will be backfilled with clean soil and vegetation planted.

Alternative 5 also includes the remediation of arsenic contaminated attic dust in selected residences and the decontamination of the drainage ditch pipe as described under Alternative 2.

4.1.5.2 Effectiveness

Removal of the contaminated soil to off-site secure treatment and disposal facility virtually eliminates the on-site risks associated with exposure pathways. This alternative would ensure the RGOs would be met. Most of the RAOs would be met except for permanently and/or significantly reducing the M/T/V in that no treatment technologies will be used. Long-term monitoring will not be needed under this alternative.

4.1.5.3 Implementability

Several factors impact the implementability of this alternative. Off-site treatment capacity may be limited and more than one facility may have to be used depending on volume to be shipped from the site. The other factor which can impact the implementability of this alternative is the availability of enough trucks to make the loading and transportation operation efficient.

4.1.5.4 Cost

The costs associated with this alternative are volume and transportation dependent. Moderate to high costs are associated with this alternative. Minimal capital costs are incurred; however, the O&M, transportation, and disposal are the bulk of the costs.

4.1.6 Alternative 6—Off-Site Transportation and Subtitle C Landfilling

4.1.6.1 Description

This alternative consists of transporting contaminated soils off-site to a RCRA secured Subtitle C landfill. Contaminated OU-4 surface soils would be excavated and transported from each residence/parcel to a central area on the main facility for consolidation and staging. From there, off-site shipment of soil in trucks to a RCRA landfill could be initiated. This alternative will remove all contaminated soils from the OU-4 Site. Note that excavated soils could be used for OU-3 backfill provided that OU-3 and OU-4 remediation occur at the same time, the OU-3 Site earthwork can be balanced, and contaminant levels do not exceed OU-3 paved cleanup goals. Additionally, the OU-4 excavated soils could be used as backfill in unpaved areas, but only if the unpaved cleanup criteria are met.

Water would be used to minimize fugitive dust emissions during soil excavation, transport, and handling. Any stockpiles of material during interim storage would be covered by tarps or plastic sheeting to minimize fugitive dust and runon/runoff emissions. Surface water runoff, fugitive emissions and treated soils would be monitored to ensure that the RAOs were being met.

After removal of all applicable contaminated soils, the excavations will be backfilled with clean soil and vegetation planted.

Alternative 6 also includes the remediation of arsenic contaminated attic dust in selected residences and the decontamination of the drainage ditch pipe as described under Alternative 2.

4.1.6.2 Effectiveness

Removal of the contaminated soil to off-site secure RCRA permitted landfill virtually eliminates the on-site risks associated with exposure pathways. This alternative would ensure the RGOs would be met. Most of the RAOs would be met except for permanently and/or significantly reducing the M/T/V in that no treatment technologies will be used. Long-term monitoring will not be needed under this alternative.

4.1.6.3 Implementability

Several factors impact the implementability of this alternative. Annual landfill capacity may be limited and more than one RCRA landfill may have to be used depending on volume to be shipped from the site. The other factor which can impact the implementability of this alternative is the availability of enough trucks to make the loading and transportation operation efficient.

4.1.6.4 Cost

The costs associated with this alternative are volume and transportation dependent. Moderate to high costs are associated with this alternative. Minimal capital costs are incurred; however, the O&M, transportation, and disposal are the bulk of the costs.

4.2 Screening of Soil Alternatives for Further Evaluation

4.2.1 Effectiveness

Alternative 1 is not effective in achieving any of the RAOs. Alternatives 2 through 6 are potentially effective in achieving RAOs.

4.2.2 Implementability

All of the alternatives are implementable. Alternative 1 is easiest to implement, followed by Alternatives 6, 5, 3, 2, and 4.

4.2.3 Cost

Alternative 1 is the least costly of all of the alternatives, followed by Alternatives 3, 2, 4, 6, and 5.

4.3 Selection of Alternatives for Further Evaluation

Alternative 1 (no action) is retained for detailed analysis as required by the NCP. This alternative serves as a baseline for decision makers to evaluate the other alternatives.

Of the treatment alternatives, Alternative 3 is retained for further consideration since it can achieve RAOs through treatment. Alternatives 2 and 4 (soil washing, chemical extraction) are eliminated from further consideration since washing and extraction do not treat the contamination, but remove it from the soil. Additional treatment would be required to address the spent solution or solvent. Alternatives 5 and 6 (treatment/off-site disposal, off-site disposal) are retained for further consideration primarily as effective and expedient remedial actions for soils.

Section 5
Detailed Analysis of Alternatives

This section provides a detailed analysis of the remedial alternatives developed and carried through screening in Section 4. For soil, four of the six alternatives were carried through the screening process presented in Section 4. These are:

- Alternative 1 — No Action
- Alternative 2 — Excavation, Transportation to Main Facility (OU-3) for Treatment with Solidification/Stabilization and On-Site (OU-3) Disposal, and Attic Dust Decontamination
- Alternative 3 — Excavation, Transportation Off-Site for Treatment and Disposal in Subtitle D Landfill, and Attic Dust Decontamination
- Alternative 4 — Excavation, Transportation to Main Facility for Consolidation, Evaluation, and Transportation to and Disposal at Subtitle C or D Landfill, or Use as OU-3 Backfill, and Attic Dust Decontamination

5.1 Evaluation Criteria

The alternatives are evaluated against the threshold and primary balancing criteria specified in the NCP and the FS Guidance (EPA 1988) to ensure that the selected remedial alternative will: protect human health and the environment, comply with or include a waiver of ARARs, be cost-effective, utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and address the statutory preference for treatment as a principal element. The modifying criteria of state and community acceptance will be addressed by EPA after this FS is completed and prior to the finalization of the ROD.

The nine FS evaluation criteria specified in the NCP are:

- Threshold Criteria
  - Overall Protection of Human Health and the Environment
  - Compliance with ARARs
- Primary Balancing Criteria
  - Short-Term Effectiveness
  - Long-Term Effectiveness

- Reduction of Toxicity, Mobility and Volume Through Treatment
- Implementability
- Cost

- Modifying Criteria
  - State Acceptance
  - Community Acceptance

These criteria are further defined by a set of subcriteria and factors described in the FS guidance (EPA 1988). While all nine criteria are important, they are weighed differently in the decision-making process depending on whether they describe a required level of performance (threshold criteria), provide for consideration of technical merits (primary balancing criteria), or involve the evaluation of non-EPA reviewers that may influence an EPA decision (modifying criteria). Explanations of the criteria are presented below.

5.1.1 Overall Protection of Human Health and the Environment

Each alternative was assessed to determine whether it can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established during development of RGs. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

5.1.2 Compliance with ARARs

Each alternative was assessed to determine whether it will attain ARARs under federal and state environmental or facility siting laws, or provide grounds for invoking one of the waivers.

5.1.3 Long-Term Effectiveness and Permanence

Each alternative was assessed for the long-term effectiveness and permanence it presents, along with the degree of certainty that the alternative will prove successful. Factors considered as appropriate included the

- magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their M/T/V and propensity to bioaccumulate.

- adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste. This factor addresses the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative; and the potential exposure pathways and risks posed should the remedial action need replacement.

5.1.4 Reduction of Mobility/Toxicity/Volume Through Treatment

The degree to which each alternative employs recycling or treatment that reduces M/T/V was assessed, including how treatment is used to address the principal threats posed by the site. Factors considered as appropriate included the following:

- treatment or recycling processes the alternatives employ and the materials they will treat;

- amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;

- degree of expected reduction of M/T/V of the waste due to treatment or recycling and the specification of which reduction(s) are occurring;

- degree to which the treatment is irreversible;

- type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents; and

- degree to which treatment reduces the inherent hazards posed by principal threats at the site.

5.1.5 Short-Term Effectiveness

The short-term effectiveness of each alternative was assessed considering the

- short-term risks that might be posed to the community during implementation of an alternative,

- potential impacts on workers during remedial action and the effectiveness and reliability of protective measures,

- potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation, and

- time until protection is achieved.

5.1.6 Implementability

The ease or difficulty of implementing each alternative was assessed by considering the following types of factors as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (e.g., off-site disposal).

- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

5.1.7 Cost

For each alternative, a cost estimate with an expected accuracy of -30 to +50 percent is developed in accordance with the EPA Remedial Action Costing Procedures Manual. Cost estimates for each alternative are based on conceptual engineering and design. The type of costs that were assessed included

- capital costs, including both direct and indirect costs;
- annual O&M; and
- net present worth of capital and O&M costs.

The present worth of each alternative provides the basis for the cost comparison. The present worth cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life.

The present worth analysis was performed on all remedial alternatives using a 7 percent discount rate over a period of 30 years. Appendix A contains spreadsheets showing each component of the present worth costs.

5.1.8 State Acceptance

Assessment of State concerns will be completed following comment on the RI and FS reports, and the proposed plan. State concerns are fully addressed in the ROD. The State concerns that shall be assessed include the

- State's position and key concerns related to the preferred alternative and other alternatives, and

- State comments on ARARs or the proposed use of waivers.

5.1.9 Community Acceptance

This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or categorically reject. Assessment of community concerns will be completed following comment on the RI and FS reports, and the preferred alternative proposed plan by the public. Community concerns are addressed in the ROD.

5.2 Analysis of Alternatives

In order to establish priority among these criteria, they are separated into three groups. The first two criteria listed are threshold criteria, and must be satisfied by the remedial action alternative being considered. The next five criteria are secondary criteria used as balancing criteria among those alternatives which satisfy the threshold criteria. The last two criteria are not evaluated during the FS. State and community acceptance is evaluated by EPA during the public comment period of the proposed plan, and an EPA responsiveness summary is incorporated into the ROD.

The objective of this section is to evaluate each of the alternatives for site remediation, individually on the basis of the threshold and balancing criteria. A summary of this analysis is presented in Table 5-1. A comparative analysis of how the seven criteria are satisfied by each of the alternatives is presented in Section 6.

Table 5-1
Summary of Remedial Alternatives Evaluation
Woolfolk OU4 Site
Fort Valley, Georgia

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
1 – No Action	Does not eliminate exposure pathways or reduce the level of risk. Does not limit migration of or remove contaminants.	Chemical-specific ARARs are not met. Action-specific ARARs do not apply.	The contaminated material is a long-term impact. RGs are not met.	No reduction of M/T/V is realized.	Level D protective equipment is required during sampling.	None	<1	$243,000
2 – Excavation, Transportation to Main Facility (OU3) for Treatment with Solidification/ Stabilization, Onsite (OU3) Disposal	Eliminates exposure pathways and reduces the level of risk. Removes contamination and eliminates further migration.	ARARs are met through excavation and onsite treatment before onsite disposal.	Long-term public health threats associated with surface soil are greatly reduced.	S/S may increase volume of treated material and does not decrease the toxicity of encapsulated metals-contaminated soil.	Level D protective equipment required during all activities. Excavation and grading may result in potential release of dust and require upgrade to Level C protective equipment. Noise nuisance from use of heavy equipment.	TCLP criteria would need to be met prior to onsite (OU3) disposal. Coordination of excavation activities to minimize impacts to residents.	2	$8.5 million
3 – Excavation, Transportation to Main Facility for Treatment with Solidification/ Stabilization followed by Offsite Disposal	Eliminates exposure pathways and reduces the level of risk. Removes contamination and eliminates further migration.	ARARs are met through excavation and offsite treatment and disposal.	Long-term public health threats associated with surface soil are greatly reduced.	S/S may increase volume of treated material and does not decrease the toxicity of encapsulated metals-contaminated soil.	Level D protective equipment required during all activities. Excavation and grading may result in potential release of dust and require upgrade to Level C protective equipment. Noise nuisance from use of heavy equipment.	Coordination of excavation activities to minimize impacts to residents.	3	$17.2 million
4 – Excavation, Transportation to Main Facility(OU3) for Consolidation, Evaluation and Offsite Disposal or use as OU3 backfill	Eliminates exposure pathways and reduces the level of risk. Removes contamination and eliminates further migration.	ARARs are met through excavation and offsite disposal.	Long-term public health threats associated with surface soil are greatly reduced.	M/T/V at the site are reduced by removal, not by treatment.	Level D protective equipment required during all activities. Excavation and grading may result in potential release of dust and require upgrade to Level C protective equipment. Noise nuisance from use of heavy equipment.	Coordination of excavation activities to minimize impacts to residents.	3	Subtitle C -$30.4 million Subtitle D -$14.1 million Use as OU3 backfill -$4.5 million

5.2.1 Alternative 1—No Action

5.2.1.1 Overall Protection of Human Health and the Environment

Because remedial actions would not be initiated as part of this alternative, it would not provide any increased protection to human health. If no action is taken, contaminants would remain on-site.

5.2.1.2 Compliance with ARARs

This alternative does not achieve the RAOs or chemical-specific ARARs (soil RG levels) established for the contaminated surface soil. Action-specific ARARs do not apply to this alternative since further remedial actions will not be conducted.

5.2.1.3 Long-Term Effectiveness and Permanence

The continued exposure of on-site receptors to surface soil is a potential long-term impact of this alternative. The RGs derived for protection of human health and would not be met. Because contaminated material remains on-site under this alternative, a review/reassessment of the conditions at the site would be performed at 5-year intervals to ensure that the remedy does not become a greater risk to human health and the environment.

5.2.1.4 Reduction of Mobility/Toxicity/Volume Through Treatment

No reductions in contaminant M/T/V are realized under this alternative.

5.2.1.5 Short-Term Effectiveness

Since no further remedial actions would be implemented at the site, this alternative poses no short-term risks to on-site workers. It is assumed that Level D personal protection would be used when sampling surface soil.

5.2.1.6 Implementability

This alternative could be implemented immediately because monitoring equipment is readily available and procedures are in place.

5.2.1.7 Cost

The total present worth cost for this alternative is $243,000. Detailed cost estimates are presented in Appendix A. There are no capital costs for this alternative.

5.2.2 Alternative 2—Excavation and On-Site (OU-3) Treatment with Solidification/Stabilization and On-Site (OU-3) Disposal

5.2.2.1 Overall Protection of Human Health and the Environment

Removal of contaminants from surface soil with on-site treatment eliminates all risks associated with the exposure pathways. Attic dust decontamination reduces risks associated with attic dust exposure pathways.

5.2.2.2 Compliance with ARARs

This alternative achieves the RAOs and chemical-specific ARARs (soil RGs) established for the contaminated surface soils at the site since areas of concern are treated to meet RGs prior to on-site (OU-3) disposal. Air quality and emission standards also would have to be met during the implementation of this alternative. In addition, this alternative would require compliance with RCRA removal, treatment, transportation, and land disposal regulations.

5.2.2.3 Long-Term Effectiveness and Permanence

Excavation and on-site treatment for inorganics eliminates the long-term health risks at the site by effectively removing the source of contamination. Risks associated with direct contact or migration of waste would be eliminated. Five-year reviews will not be necessary since no soil above health-based goals would remain at the site and treated soils would be consolidated at OU-3.

5.2.2.4 Reduction of Mobility/Toxicity/Volume Through Treatment

This alternative significantly reduces the mobility of inorganic contaminants; however, the use of immobilization agents in the surface soils may increase volume.

5.2.2.5 Short-Term Effectiveness

Short- and long-term monitoring would be required under this alternative, since construction activities could result in the release of fugitive dust. Also, operation of heavy equipment during construction would produce some noise nuisance. Air monitoring during construction activities would be necessary to ensure that a safe working environment is maintained, and that no threat to human health or the environment is created by air emissions from any of the areas during construction. Activities resulting in increases in ambient noise levels, windblown dust, and soil erosion would be mitigated by limiting the hours of operation, soil moisture control, erosion and surface runoff control measures, and reestablishing vegetative cover. The excavation work would be staged and coordinated with the backfill and seeding activities to minimize the potential for dust production and erosion. Health and safety requirements during the implementation of this alternative would include the use of personal protection equipment by all construction personnel when necessary. It is assumed that Level D personal protection would be used, with Level C as a contingency, during construction activities. Equipment and personnel decontamination facilities would be necessary at OU-3. A heavy equipment washdown pad would be constructed and excavation equipment would be decontaminated prior to leaving the OU-3 Site. Wash water would be treated on-site or stored in drums and removed for off-site treatment or through the groundwater treatment system operating at the site.

5.2.2.6 Implementability

Excavation, solidification/stabilization, and backfilling of treated soil (at OU-3) are established methods that have been successfully demonstrated in large scale applications for the COCs. Conditions external to the site, such as equipment availability, materials, and services present no problems at this time.

Monitoring the excavation of contaminated material and operation of the treatment system would be required to verify that the excavated areas meet the anticipated RGs.

5.2.2.7 Cost

The total present worth for Alternative 3 is $9.4 million. Estimated capital costs are $8.4 million and estimated O&M costs are $1 million. Detailed cost estimates are presented in Appendix A. Note that the costs for Alternative 3 assume that the excavated soils would require treatment prior to disposal. If, after evaluation, it is determined that no treatment would be required prior to backfilling the soils in OU-3, remediation costs for OU-4 could be reduced by as much as 50 percent (see Section 5.2.4.7).

5.2.3 Alternative 3 — Excavation and Treatment with Solidification/Stabilization and Off-Site Disposal

5.2.3.1 Overall Protection of Human Health and the Environment

Removal of contaminants from surface soil with off-site treatment and disposal eliminates all risks associated with the exposure pathways. Attic dust decontamination reduces risks associated with attic dust exposure pathways.

5.2.3.2 Compliance with ARARs

This alternative achieves the RAOs and chemical-specific ARARs (soil RGs) established for the contaminated surface soils at the site since areas of concern are treated to meet RGs prior to disposal. Air quality and emission standards also would have to be met during the implementation of this alternative. In addition, this alternative would require compliance with RCRA removal, treatment, transportation, and land disposal regulations.

5.2.3.3 Long-Term Effectiveness and Permanence

Excavation and off-site treatment and disposal eliminates the long-term health risks at the site by effectively removing the source of contamination. Risks associated with direct contact or migration of waste would be eliminated. Five-year reviews will not be necessary since no soil above health-based goals would remain at the site.

5.2.3.4 Reduction of Mobility/Toxicity/Volume Through Treatment

This alternative significantly reduces the mobility of inorganic contaminants; however, the use of immobilization agents in the surface soils may increase volume.

5.2.3.5 Short-Term Effectiveness

Short- and long-term monitoring would be required under this alternative, since construction activities could result in the release of fugitive dust. Also, operation of heavy equipment during construction would produce some noise nuisance. Air monitoring during construction activities would be necessary to ensure that a safe working environment is maintained, and that no threat to human health or the environment is created by air emissions from any of the areas during construction. Activities resulting in increases in ambient noise levels, windblown dust, and soil erosion would be mitigated by limiting the hours of operation, soil moisture control, erosion and surface runoff control measures, and reestablishing vegetative cover. The excavation work would be staged and coordinated with the backfill and seeding activities to minimize the potential for dust production and erosion. Health and safety requirements during the implementation of this alternative would include the use of personal protection equipment by all construction personnel when necessary. It is assumed that Level D personal protection would be used, with Level C as a contingency, during construction activities. Equipment and personnel decontamination facilities would be necessary at OU-3. A heavy equipment washdown pad would be constructed and excavation equipment would be decontaminated prior to leaving the OU-3 Site. Wash water would be treated on-site or stored in drums and removed for off-site treatment or through the groundwater treatment system operating at the site.

5.2.3.6 Implementability

Excavation, off-site solidification/stabilization, and off-site disposal are established methods that have been successfully demonstrated in large scale applications for the COCs. Conditions external to the site, such as equipment availability, materials, and services present no problems at this time.

Monitoring the excavation of contaminated material and operation of the treatment system would be required to verify that the excavated areas meet the anticipated RGs.

5.2.3.7 Cost

The total present worth for Alternative 3 is $18 million. Estimated capital costs are $17.6 million and estimated O&M costs are $500,000. Detailed cost estimates are presented in Appendix A.

5.2.4 Alternative 4—Excavation, Transportation to Main Facility for Consolidation, Evaluation, and Transportation to and Disposal at Subtitle C or D Landfill, or Use as OU-3 Backfill

5.2.4.1 Overall Protection of Human Health and the Environment

Excavating of contaminated soil from the site and transporting it to an off-site secure RCRA regulated landfill for disposal would eliminate exposure pathways and significantly reduce level of risk at OU-4 Site. Attic dust decontamination reduces risks associated with attic dust exposure pathways.

5.2.4.2 Compliance with ARARs

Transportation of contaminated soil would be in accordance with applicable Department of Transportation hazardous material regulations. Disposal at a RCRA permitted Subtitle C landfill would be in compliance with ARARs.

5.2.4.3 Long-Term Effectiveness and Permanence

No long-term public health threats would remain on-site related to soil. Property can be returned to viable land use.

5.2.4.4 Reduction of Mobility/Toxicity/Volume Through Treatment

Removal of the contaminated soil from the site meets the criteria of reduction of mobility/toxicity/volume relative to the OU-4 Site through removal.

5.2.4.5 Short-Term Effectiveness

During on-site removal action Level D personnel protective equipment is required. The potential exists for a higher level of protection to be used during excavation or loading of trucks. Excavation and grading may result in release of nuisance or contaminated dust. Use of heavy equipment may cause a noise nuisance. Engineering controls will be utilized for controlling the dust. Higher levels of personnel protection may become necessary for on-site workers during activities if engineering controls do not reduce dust, or noise.

5.2.4.6 Implementability

This alternative has minimal technical considerations once representative samples are collected and presented to the receiving landfill(s) for their acceptance evaluation, and providing requirements specified in 40 CFR 268.30 are met. Historical knowledge and current information about soil chemical and physical characteristics would be provided to the landfill(s).

5.2.4.7 Costs

The total present worth for Alternative 4 (Subtitle C landfill) is $31.3 million. Estimated capital costs are $30.8 million and estimated O&M costs are $500,000.

If the soil is characterized as nonhazardous and disposal in a Subtitle D landfill is possible, the total present worth for Alternative 4 (Subtitle D landfill) is $15 million. Estimated capital costs are $14.5 million and estimated O&M costs are $500,000.

If the soil can be used as backfill at the OU-3 Site without treatment, the total present worth for Alternative 4 (Subtitle D landfill) is $5.3 million. Estimated capital costs are $4.8 million and estimated O&M costs are $500,000. Detailed cost estimates are presented in Appendix A.

Table 5-1
Summary of Remedial Alternatives Evaluation
Woolfolk OU4 Site
Fort Valley, Georgia

Remedial Alternative	Threshold Criteria		Balancing Criteria					
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability		Cost Approx. Total Present Worth
						Technical/Engineering Considerations	Estimated Time for Implementation (years)	
1 -- No Action	Does not eliminate exposure pathways or reduce the level of risk. Does not limit migration of or remove contaminants.	Chemical-specific ARARs are not met. Action-specific ARARs do not apply.	The contaminated material is a long-term impact. RGs are not met.	No reduction of M/T/V is realized.	Level D protective equipment is required during sampling.	None	<1	$243,000
2 – Excavation, Transportation to Main Facility (OU3) for Treatment with Solidification/ Stabilization, Onsite (OU3) Disposal	Eliminates exposure pathways and reduces the level of risk. Removes contamination and eliminates further migration.	ARARs are met through excavation and onsite treatment before onsite disposal.	Long-term public health threats associated with surface soil are greatly reduced.	S/S may increase volume of treated material and does not decrease the toxicity of encapsulated metals-contaminated soil.	Level D protective equipment required during all activities. Excavation and grading may result in potential release of dust and require upgrade to Level C protective equipment. Noise nuisance from use of heavy equipment.	TCLP criteria would need to be met prior to onsite (OU3) disposal. Coordination of excavation activities to minimize impacts to residents.	2	$9.4 million
3 – Excavation, Transportation to Main Facility for Treatment with Solidification/ Stabilization followed by Offsite Disposal	Eliminates exposure pathways and reduces the level of risk. Removes contamination and eliminates further migration.	ARARs are met through excavation and offsite treatment and disposal.	Long-term public health threats associated with surface soil are greatly reduced.	S/S may increase volume of treated material and does not decrease the toxicity of encapsulated metals-contaminated soil.	Level D protective equipment required during all activities. Excavation and grading may result in potential release of dust and require upgrade to Level C protective equipment. Noise nuisance from use of heavy equipment.	Coordination of excavation activities to minimize impacts to residents.	3	$18 million
4 – Excavation, Transportation to Main Facility(OU3) for Consolidation, Evaluation and Offsite Disposal or use as OU3 backfill	Eliminates exposure pathways and reduces the level of risk. Removes contamination and eliminates further migration.	ARARs are met through excavation and offsite disposal.	Long-term public health threats associated with surface soil are greatly reduced.	M/T/V at the site are reduced by removal, not by treatment.	Level D protective equipment required during all activities. Excavation and grading may result in potential release of dust and require upgrade to Level C protective equipment. Noise nuisance from use of heavy equipment.	Coordination of excavation activities to minimize impacts to residents.	3	Subtitle C -$31.3 million Subtitle D -$15 million Use as OU3 backfill -$5.3 million

Section 6
Comparative Analysis of Alternatives

This section presents a comparative analysis of the surface soil alternatives based on the threshold and balancing evaluation criteria. The objective of this section is to compare and contrast the alternatives so that decision makers may select a preferred alternative for presentation in the ROD.

The alternatives are presented here to give decision makers a range of potential actions that could be taken to remediate this site. For soil, these actions include:

- no action,
- ex situ solidification/stabilization and on-site (OU-3) disposal of treated soil,
- solidification/stabilization and off-site disposal of treated soil, and
- off-site disposal.

Table 6-1 presents a summary of each remedial alternative along with ranking scores for each evaluation criterion. Each alternative's performance against the criteria (except for present worth) was ranked on a scale of 0 to 5, with 0 indicating that none of the criterion's requirements were met and 5 indicating all of the requirements were met. The ranking scores are not intended to be quantitative or additive, but rather are summary indicators of each alternative's performance against the CERCLA evaluation criteria. The ranking scores combined with the present worth costs provide the basis for comparison among alternatives.

Alternatives 2 through 4 are ranked higher than Alternative 1 across all the criteria except short-term effectiveness and implementability. Alternatives 2 through 4 are the same for overall protection, compliance with ARARs, and long-term effectiveness and permanence, and reduction of M/T/V. Alternative 3 is ranked lower than Alternatives 2 and 4 in short-term effectiveness and implementability because of potential difficulty in finding an off-site treatment facility within a reasonable distance from the site.

Table 6-1
Comparative Analysis of Remedial Alternatives
Woolfolk Chemical Works Site, OU-4, Fort Valley, Georgia

Remedial Alternative	Criteria Rating						Approximate Present Worth ($)
	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of M/T/V Through Treatment	Short-Term Effectiveness	Implementability	
1 — No Action	0	0	0	0	5	5	$243,000
2 — Excavation, Transportation to Main Facility (OU-3) for Treatment with Solidification/ Stabilization (S/S) and On-Site(OU-3) Disposal; Attic Dust Decontamination	5	5	5	4	4	4	$9.4 million
3 — Excavation, Transportation to Main Facility (OU-3), Treatment with S/S and Off-Site Disposal in Subtitle D Landfill; Attic Dust Decontamination	5	5	5	4	3	3	$18 million
4 — Excavation, Transportation to Main Facility for Consolidation, Evaluation and Off-Site Disposal in Subtitle C or D Landfill or Use as OU-3 Backfill; Attic Dust Decontamination	5	5	5	4	4	4	Subtitle C– $31.3 million Subtitle D– $15 million Use as OU-3 backfill– $5.3 million

A ranking of "0" indicates noncompliance, while a ranking of "5" indicates complete compliance.

Section 7
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Appendix A
FS Cost Estimates

Alternative 1 -- No Action

Site Name: Woolfolk OU4 Site
Site Location: Fort Valley, Georgia

PRESENT WORTH COST

Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
No Action (5-Year Review)				$0
Subtotal - Capital Cost				$0
Contractor Fee (10% of Capital Cost)				$0
Legal Fees, Licenses & Permits (5% of Capital Cost)				$0
Engineering & Administrative (15% of Capital Cost)				$0
Subtotal				$0
Contingency (25% of Subtotal)				$0
TOTAL CONSTRUCTION COST				$0
PRESENT WORTH O&M COST				$242,971
TOTAL PRESENT WORTH COST				$242,971

Alternative 1 -- No Action

Site Name: Woolfolk OU4 Site
Site Location: Fort Valley, Georgia

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
5-YEAR REVIEWS						
Personnel (2-man crew @ 7 12-hour days)	hours	168	$50	$1,680	30	$20,847
Supplies/ Travel	days	6	$3,000	$3,600	30	$44,673
Soil Sampling and Lab Testing	sample	100	$500	$10,000	30	$124,090
Report Preparation	lump sum	1	$5,000	$1,000	6	$4,767
O&M SUBTOTAL				$16,280		$194,377
Contractor Fee (10% of O&M cost)				$1,628		$19,438
Legal Fees, Licenses & Permits (5% of O&M Cost)				$81		$972
CONTINGENCY (25% of Subtotal)				$4,070		$48,594
SUBTOTAL				$20,350		$242,971

Alternative 2 (Soil)-- Excavation, Onsite (OU3) Treatment w/ Solidification/Stabilization and Onsite (OU3) Disposal; Attic Dust Decontamination

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Woolfolk Site OU4
Site Location: Fort Valley, Georgia

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
Transport Equipment & Staff	each	1	$100,000	$100,000
Temporary Facilities	each	1	$75,000	$75,000
EXCAVATION				
Soil Excavation	cy	57,000	$10	$570,000
Dust Control & Placement in Storage Area	cy	57,000	$10	$570,000
Backfill Excavated Areas with Clean Fill/ Move Treated Soil	cy	60,000	$10	$600,000
Grading & Compacting	acre	40	$5,000	$200,000
Seed & Mulch	acre	40	$2,000	$80,000
ONSITE TREATMENT				
Treatability Study	lump sum	1	$150,000	$150,000
Solidification/Stabilization	ton	57,000	$35	$1,995,000
DRAINAGE DITCH PIPE CLEANING	linear foot	10,500	$51	$535,500
ATTIC DUST DECONTAMINATION				
Decontamination and Replacement of Insulation				
Pre-clean, HEPA vacuum, and wet-clean	home	60	$810	$48,600
Containment Barrier	home	60	$300	$18,000
Portable Decontamination Facility	home	60	$38	$2,280
Negative air machine	home	60	$294	$17,640
Air Monitoring	home	60	$500	$30,000
Post-Decontamination inspection/sampling	home	60	$500	$30,000
Removal of contaminated insulation	home	19	$1,740	$33,060
Installation of new insulation	home	19	$720	$13,680
Disposal of contaminated material (disposal charges)	cy	200	$21	$4,200
EQUIPMENT & MATERIALS				
Health & Safety Equipment	each	1	$100,000	$100,000
Subtotal - Capital Cost				$5,172,960
Contractor Fee (10% of Capital Cost)				$517,296
Legal Fees, Licenses & Permits (5% of Capital Cost)				$258,648
Engineering & Administrative (15% of Capital Cost)				$775,944
Subtotal				$6,724,848
Contingency (25% of Subtotal)				$1,681,212
TOTAL CONSTRUCTION COST				$8,406,060
PRESENT WORTH O&M COST				$953,296
TOTAL PRESENT WORTH COST				$9,359,356

Alternative 2 (Soil)-- Excavation, Onsite (OU3) Treatment w/ Solidification/Stabilization and Onsite (OU3) Disposal; Attic Dust Decontamination

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Woolfolk Site OU4
Site Location: Fort Valley, Georgia

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
TREATMENT SYSTEM MONITORING						
Soil Sample Analyses	week	52	$2,000	$104,000	5	$426,421
EXCAVATION MONITORING						
Confirmatory Sample Analyses	samples	60	$500	$30,000	5	$123,006
AIR QUALITY MONITORING	week	52	$1,000	$52,000	5	$213,210
SUBTOTAL				$186,000		$762,637
CONTINGENCY (25% of Subtotal)				$46,500		$190,659
TOTAL				$232,500		$953,296

Estimated acreage requiring remediation: 40 acres
This option assumes that soil would be characterized as hazardous, undergo onsite solidification/stabilization and be disposed at OU3 in conjunction with OU3 soil remediation.
Backfill volume assumes a 5% increase in volume of soil treated via solidification/stabilization
1 ton = 1 cy

Attic Dust Decontamination is based on the following assumptions: 60 houses with attic dust arsenic concentrations of 71 to 1000 mg/kg will require decontamination. Each home has a surface area of 4,500 sq ft that will require decontamination. Of the 60 houses, 19 (with concentrations ranging from 500 to 1000 mg/kg arsenic) will require removal of 3,000 sq ft of old insulation and installation of 3,000 sq ft of new installation. Assume hazardous landfill disposal for contaminated materials.

Alternative 3 (Soil)-- Excavation, Treatment w/ Solidification/Stabilization and Offsite Disposal; Attic Dust Decontamination Site Name: Woolfolk Site OU4 Site Location: Fort Valley, Georgia			PRESENT WORTH COST Discount Rate: 7%	
ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
Transport Equipment & Staff	each	1	$100,000	$100,000
Temporary Facilities	each	1	$75,000	$75,000
EXCAVATION				
Soil Excavation	cy	57,000	$10	$570,000
Dust Control & Placement in Storage Area	cy	57,000	$10	$570,000
Backfill Excavated Areas with Clean Fill/Treated Soil	cy	57,000	$5	$285,000
Grading & Compacting	acre	40	$5,000	$200,000
Seed & Mulch	acre	40	$2,000	$80,000
TRANSPORTATION				
Transport soil to disposal facility within 350 mile radius	truckload	3,200	$700	$2,240,000
TREATMENT/DISPOSAL				
Solidification/Stabilization	ton	57,000	$35	$1,995,000
Disposal (Landfill nonhazardous solid bulk waste)	ton	60,000	$65	$3,900,000
DRAINAGE DITCH PIPE CLEANING	linear foot	10,500	$51	$535,500
ATTIC DUST DECONTAMINATION				
Decontamination and Replacement of Insulation				
Pre-clean, HEPA vacuum, and wet-clean	home	60	$810	$48,600
Containment Barrier	home	60	$300	$18,000
Portable Decontamination Facility	home	60	$38	$2,280
Negative air machine	home	60	$294	$17,640
Air Monitoring	home	60	$500	$30,000
Post-Decontamination inspection/sampling	home	60	$500	$30,000
Removal of contaminated insulation	home	19	$1,740	$33,060
Installation of new insulation	home	19	$720	$13,680
Disposal of contaminated material (disposal charges)	cy	200	$21	$4,200
EQUIPMENT & MATERIALS				
Health & Safety Equipment	each	1	$100,000	$100,000
Subtotal - Capital Cost				$10,847,960
Contractor Fee (10% of Capital Cost)				$1,084,796
Legal Fees, Licenses & Permits (5% of Capital Cost)				$542,398
Engineering & Administrative (15% of Capital Cost)				$1,627,194
Subtotal				$14,102,348
Contingency (25% of Subtotal)				$3,525,587
TOTAL CONSTRUCTION COST				$17,627,935
PRESENT WORTH O&M COST				$420,364
TOTAL PRESENT WORTH COST				$18,048,299

Alternative 3 (Soil)-- Excavation, Treatment w/ Solidification/Stabilization and Offsite Disposal; Attic Dust Decontamination Site Name: Woolfolk Site OU4 Site Location: Fort Valley, Georgia				OPERATION & MAINTENANCE COSTS Discount Rate: 7%		
ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
TREATMENT SYSTEM MONITORING						
Soil Sample Analyses	week	52	$2,000	$104,000	2	$188,034
EXCAVATION MONITORING						
Confirmatory Sample Analyses	samples	60	$500	$30,000	2	$54,241
AIR QUALITY MONITORING	week	52	$1,000	$52,000	2	$94,017
SUBTOTAL				$186,000		$336,291
CONTINGENCY (25% of Subtotal)				$46,500		$84,073
TOTAL				$232,500		$420,364

Estimated acreage requiring remediation: 40 acres
This option assumes that soil would be defined as hazardous and would undergo treatment prior to disposal in Subtitle D landfill.
Backfill volume assumes a 5% increase in volume of soil treated via solidification/stabilization
1 ton = 1 cy
Costs assume a 5-year treatment time frame.

Transportation and disposal costs developed from R.S. Means 1999.

Attic Dust Decontamination is based on the following assumptions: 60 houses with attic dust arsenic concentrations of 71 to 1000 mg/kg will require decontamination. Each home has a surface area of 4,500 sq ft that will require decontamination. Of the 60 houses, 19 (with concentrations ranging from 500 to 1000 mg/kg arsenic) will require removal of 3,000 sq ft of old insulation and installation of 3,000 sq ft of new installation. Assume hazardous landfill disposal for contaminated materials.

Alternative 4 (Soil) -- Excavation, Offsite Transportation, and Disposal at Subtitle C Landfill; Attic Dust Decontamination

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Woolfolk OU4 Site
Site Location: Fort Valley, Georgia

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
Transport Equipment & Staff	each	1	$100,000	$100,000
Temporary Facilities	each	1	$75,000	$75,000
EXCAVATION				
Soil Excavation	cy	57,000	$10	$570,000
Dust Control & Placement in Storage Area	cy	57,000	$10	$570,000
Backfill Excavated Areas with Clean Fill/Treated Soil	cy	57,000	$10	$570,000
Grading & Compacting	acre	40	$5,000	$200,000
Seed & Mulch	acre	40	$2,000	$80,000
OFFSITE LANDFILLING				
Truck Transport	truckload	3,200	$700	$2,240,000
Landfill Hazardous Solid Bulk Waste requiring stabilizatio	ton	57,000	$241	$13,737,000
DRAINAGE DITCH PIPE CLEANING	linear foot	10,500	$51	$535,500
ATTIC DUST DECONTAMINATION				
Decontamination and Replacement of Insulation				
Pre-clean, HEPA vacuum, and wet-clean	home	60	$810	$48,600
Containment Barrier	home	60	$300	$18,000
Portable Decontamination Facility	home	60	$38	$2,280
Negative air machine	home	60	$294	$17,640
Air Monitoring	home	60	$500	$30,000
Post-Decontamination inspection/sampling	home	60	$500	$30,000
Removal of contaminated insulation	home	19	$1,740	$33,060
Installation of new insulation	home	19	$720	$13,680
Disposal of contaminated material (disposal charges)	cy	200	$21	$4,200
EQUIPMENT & MATERIALS				
Health & Safety Equipment	each	1	$100,000	$100,000
Subtotal - Capital Cost				$18,974,960
Contractor Fee (10% of Capital Cost)				$1,897,496
Legal Fees, Licenses & Permits (5% of Capital Cost)				$948,748
Engineering & Administrative (15% of Capital Cost)				$2,846,244
Subtotal				$24,667,448
Contingency (25% of Subtotal)				$6,166,862
TOTAL CONSTRUCTION COST				$30,834,310
PRESENT WORTH O&M COST				$465,565
TOTAL PRESENT WORTH COST				$31,299,875

Alternative 4 (Soil) -- Excavation, Offsite Transportation, and Disposal at Subtitle C Landfill; Attic Dust Decontamination

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Woolfolk OU4 Site
Site Location: Fort Valley, Georgia

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
PRE-LANDFILL MONITORING						
Soil Sample Analyses	week	52	$2,000	$104,000	2	$188,034
EXCAVATION MONITORING						
Confirmatory Sample Analyses	samples	100	$500	$50,000	2	$90,401
AIR QUALITY MONITORING	week	52	$1,000	$52,000	2	$94,017
SUBTOTAL				$206,000		$372,452
CONTINGENCY (25% of Subtotal)				$51,500		$93,113
TOTAL				$257,500		$465,565

This option assumes that soil would be characterized as hazardous and would require treatment prior to disposal in Subtitle C landfill.
Estimated acreage requiring remediation: 40 acres
1 ton = 1 cy
Assumes transport of 18 tons/truck load and availability of a disposal facility within 350 miles.
Assumes a 5% increase in volume of soil treated via solidification/stabilization
Transportation and disposal costs developed from R.S. Means 1999

Attic Dust Decontamination is based on the following assumptions: 60 houses with attic dust arsenic concentrations of 71 to 1000 mg/kg will require decontamination. Each home has a surface area of 4,500 sq ft that will require decontamination. Of the 60 houses, 19 (with concentrations ranging from 500 to 1000 mg/kg arsenic) will require removal of 3,000 sq ft of old insulation and installation of 3,000 sq ft of new installation. Assume hazardous landfill disposal for contaminated materials.

Alternative 4 (Soil) -- Excavation, Offsite Transportation, and Disposal at Subtitle D Landfill; Attic Dust Decontamination

PRESENT WORTH COST

Discount Rate: 7%

Site Name: Woolfolk OU4 Site
Site Location: Fort Valley, Georgia

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
Transport Equipment & Staff	each	1	$100,000	$100,000
Temporary Facilities	each	1	$75,000	$75,000
EXCAVATION				
Soil Excavation	cy	57,000	$10	$570,000
Dust Control & Placement in Storage Area	cy	57,000	$10	$570,000
Backfill Excavated Areas with Clean Fill/Treated Soil	cy	57,000	$10	$570,000
Grading & Compacting	acre	40	$5,000	$200,000
Seed & Mulch	acre	40	$2,000	$80,000
OFFSITE LANDFILLING				
Truck Transport	truckload	3,200	$700	$2,240,000
Disposal at Subtitle D Landfill	ton	57,000	$65	$3,705,000
DRAINAGE DITCH PIPE CLEANING	linear foot	10,500	$51	$535,500
ATTIC DUST DECONTAMINATION				
Decontamination and Replacement of Insulation				
Pre-clean, HEPA vacuum, and wet-clean	home	60	$810	$48,600
Containment Barrier	home	60	$300	$18,000
Portable Decontamination Facility	home	60	$38	$2,280
Negative air machine	home	60	$294	$17,640
Air Monitoring	home	60	$500	$30,000
Post-Decontamination inspection/sampling	home	60	$500	$30,000
Removal of contaminated insulation	home	19	$1,740	$33,060
Installation of new insulation	home	19	$720	$13,680
Disposal of contaminated material (disposal charges)	cy	200	$21	$4,200
EQUIPMENT & MATERIALS				
Health & Safety Equipment	each	1	$100,000	$100,000
Subtotal - Capital Cost				$8,942,960
Contractor Fee (10% of Capital Cost)				$894,296
Legal Fees, Licenses & Permits (5% of Capital Cost)				$447,148
Engineering & Administrative (15% of Capital Cost)				$1,341,444
Subtotal				$11,625,848
Contingency (25% of Subtotal)				$2,906,462
TOTAL CONSTRUCTION COST				$14,532,310
PRESENT WORTH O&M COST				$465,565
TOTAL PRESENT WORTH COST				$14,997,875

Alternative 4 (Soil) -- Excavation, Offsite Transportation, and Disposal at Subtitle D Landfill; Attic Dust Decontamination

OPERATION & MAINTENANCE COSTS

Discount Rate: 7%

Site Name: Woolfolk OU4 Site
Site Location: Fort Valley, Georgia

ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
PRE-LANDFILL MONITORING						
Soil Sample Analyses	week	52	$2,000	$104,000	2	$188,034
EXCAVATION MONITORING						
Confirmatory Sample Analyses	samples	100	$500	$50,000	2	$90,401
AIR QUALITY MONITORING	week	52	$1,000	$52,000	2	$94,017
SUBTOTAL				$206,000		$372,452
CONTINGENCY (25% of Subtotal)				$51,500		$93,113
TOTAL				$257,500		$465,565

This option assumes that soil would be characterized as nonhazardous and would require no further treatment
Estimated acreage requiring remediation: 40 acres
1 ton = 1 cy
Assumes transport of 18 tons/truck load and availability of a disposal facility within 350 miles.
Assumes a 5% increase in volume of soil treated via solidification/stabilization
Transportation and disposal costs developed from R.S. Means 1999

Attic Dust Decontamination is based on the following assumptions: 60 houses with attic dust arsenic concentrations of 71 to 1000 mg/kg will require decontamination. Each home has a surface area of 4,500 sq ft that will require decontamination. Of the 60 houses, 19 (with concentrations ranging from 500 to 1000 mg/kg arsenic) will require removal of 3,000 sq ft of old insulation and installation of 3,000 sq ft of new installation. Assume hazardous landfill disposal for contaminated materials.

Alternative 4 (Soil) -- Excavation with Use as OU3 backfill; Attic Dust Decontamination Site Name. Woolfolk OU4 Site Site Location: Fort Valley, Georgia			PRESENT WORTH COST Discount Rate: 7%	
ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL COST DOLLARS
MOBILIZATION/DEMOBILIZATION				
Transport Equipment & Staff	each	1	$100,000	$100,000
Temporary Facilities	each	1	$75,000	$75,000
EXCAVATION				
Soil Excavation	cy	57,000	$10	$570,000
Dust Control & Placement in Storage Area	cy	57,000	$10	$570,000
Backfill Excavated Areas with Clean Fill/Treated Soil	cy	57,000	$10	$570,000
Grading & Compacting	acre	40	$5,000	$200,000
Seed & Mulch	acre	40	$2,000	$80,000
DRAINAGE DITCH PIPE CLEANING	linear foot	10,500	$51	$535,500
ATTIC DUST DECONTAMINATION				
Decontamination and Replacement of Insulation				
Pre-clean, HEPA vacuum, and wet-clean	home	60	$810	$48,600
Containment Barrier	home	60	$300	$18,000
Portable Decontamination Facility	home	60	$38	$2,280
Negative air machine	home	60	$294	$17,640
Air Monitoring	home	60	$500	$30,000
Post-Decontamination inspection/sampling	home	60	$500	$30,000
Removal of contaminated insulation	home	19	$1,740	$33,060
Installation of new insulation	home	19	$720	$13,680
Disposal of contaminated material (disposal charges)	cy	200	$21	$4,200
EQUIPMENT & MATERIALS				
Health & Safety Equipment	each	1	$100,000	$100,000
Subtotal - Capital Cost				$2,997,960
Contractor Fee (10% of Capital Cost)				$299,796
Legal Fees, Licenses & Permits (5% of Capital Cost)				$149,898
Engineering & Administrative (15% of Capital Cost)				$449,694
Subtotal				$3,897,348
Contingency (25% of Subtotal)				$974,337
TOTAL CONSTRUCTION COST				$4,871,685
PRESENT WORTH O&M COST				$465,565
TOTAL PRESENT WORTH COST				$5,337,250

Alternative 4 (Soil) -- Excavation with Use as OU3 backfill; Attic Dust Decontamination Site Name: Woolfolk OU4 Site Site Location: Fort Valley, Georgia				OPERATION & MAINTENANCE COSTS Discount Rate: 7%		
ITEM DESCRIPTION	UNITS	QUANTITY	UNIT PRICE DOLLARS	TOTAL ANNUAL COST, DOLLARS	OPERATION TIME, YEARS	PRESENT WORTH
PRE-OU3 PLACEMENT MONITORING						
Soil Sample Analyses	week	52	$2,000	$104,000	2	$188,034
EXCAVATION MONITORING						
Confirmatory Sample Analyses	samples	100	$500	$50,000	2	$90,401
AIR QUALITY MONITORING	week	52	$1,000	$52,000	2	$94,017
SUBTOTAL				$206,000		$372,452
CONTINGENCY (25% of Subtotal)				$51,500		$93,113
TOTAL				$257,500		$465,565

This option assumes that soil would be charcaterized as nonhazardous and would require no further treatment
Estimated acreage requiring remediation: 40 acres
1 ton = 1 cy

Transportation and disposal costs developed from R.S. Means 1999

Attic Dust Decontamination is based on the following assumptions: 60 houses with attic dust arsenic concentrations of 71 to 1000 mg/kg will require decontamination. Each home has a surface area of 4,500 sq ft that will require decontamination. Of the 60 houses, 19 (with concentrations ranging from 500 to 1000 mg/kg arsenic) will require removal of 3,000 sq ft of old insulation and installation of 3,000 sq ft of new installation. Assume hazardous landfill disposal for contaminated matenals.